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REPORT ON THE ESTIMATED IMPACTS OF MISA IMPLEMENTATION ON WASTEWATER TREATMENT RESIDUAL PRODUCTION BY SELECTED INDUSTRIAL SECTORS IN ONTARIO

Prepared for

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EXECUTIVE SUMMARY

PURPOSE OF THE REPORT

The purpose of this report was to quantify, to the extent possible at this time, the potential impact of MISA (Municipal and Industrial Strategy for Abatement) implementation on subject waste generation in Ontario. The draft Study Report was prepared in October 1988, and the final report, with minimal revisions, was issued in April 1989.

SCOPE AND METHOD

Following discussions with MOE MISA sector specialists, and consultants familiar with similar programs in the U.S., the scope of this study was limited to the following industry groups:

i) Iron and Steel, Metal Casting and Metal Finishing Direct Dischargers

ii) Organic and Inorganic Chemical Direct and Indirect Dischargers

iii) Metal Finishing Direct and Indirect Dischargers

Information on wastewater quality currently discharged by direct dischargers was obtained from the 1986 MOE IMIS (Industrial Monitoring and Information System) database. A number of potential scenario's were assumed regarding the effluent standards likely to be imposed as a result of MISA implementation. Assumptions were made regarding the technologies likely to be used to achieve these effluent stan-

dards, and the dry solids produced by these technologies and the required effluent standards were calculated. Sludges produced were assumed to contain 20% solids, for total sludge quantity estimates. In most cases BAT (Best Available Technology) effluent concentrations, as provided in the USEPA Effluent Guidelines for the industries of interest, were assumed. Residuals produced by more and less stringent effluent guidelines were also estimated, to determine the sensitivity of the estimates to assumed effluent quality.

The subject waste fraction of the incremental residuals was based on the nature of the sludge. In some cases, where the sludge was likely to contain parameters of concern, but adequate data was not available at this time to determine if the sludge would be leachate toxic or not, a 50% subject waste component was assumed.

Estimates of incremental residuals produced by the metal finishing indirect dischargers were based on detailed data obtained from an Environment Canada Survey of the industry, carried out in 1983-1984. This data was adjusted to account for additional information obtained through discussions with other consultants, and Canadian Metal Finishing Association and Environment Canada staff representatives, and reflected changes observed within the industry since the survey was carried out. Incremental wastewater treatment residual production was calculated assuming that effluent limits imposed on metal finishing indirect dischargers in Ontario would be similar to PSES (Pretreatment Standards for Existing Sources) as outlined in the USEPA Federal Register Ruling (1981). All metal laden sludges were assumed to be at 20% solids content, and to be subject waste.

The numbers of indirect dischargers in the organic and inorganic chemical sector, and the estimated volumes of wastewater produced were obtained from an MM Dillon Study (1988).

USEPA Development Documents for these sectors were reviewed to endeavor to obtain effluent quality data on which to develop incremental wastewater residual estimates for Ontario. The data on conventional pollutants was considered unsuitable for this purpose because of the orders of magnitude difference encountered in wastewater quality information. Preliminary estimates were developed based on removal of priority pollutants only to levels outlined in the USEPA Effluent Guidelines for the sectors of interest. The methodology employed for this portion of the study applied U.S. effluent limitations and wastewater quality data to estimated Ontario flow rates.

STATUS OF DATA

Calculations on incremental waste generation by direct dischargers were based on effluent quality and loading information obtained in the 1986 MOE IMIS report, which was the most recent report available at the time of writing. It is recognized that changes may have occurred at some of the plants in the database, thus altering the pollutant load. Any potential changes since the end of 1986 were not taken into account in this study.

Estimates of incremental waste generation by the metal finishing indirect dischargers was based on data obtained from an Environment Canada Survey of the industry, carried out in 1983-1984. This information was extrapolated and modified to account for changes which have reportedly occurred in the industry since that time, and also to account for the reportedly larger size of the industry. In all cases these modifications are approximate and are based on best professional judgement.

Estimates of incremental waste generation are based on the assumption that MISA implementation in Ontario will be similar to comparable U.S. programs, and that MISA effluent requirements will be similar to the U.S. standards. As the MISA program is still under development it is not possible to comment further on the accuracy of this assumption at this time.

Estimates of incremental waste generation by the chemical sector indirect dischargers is based on estimated numbers of industries and wastewater flow rates obtained from an MM Dillon Study (1988). The numbers in the M.M. Dillon (1988) Study were developed by using scale down factors to convert information obtained for the U.S. and presented in a Report to Congress (1986) to Ontario. The report text cautions that these numbers are subject to considerable error, however, after considerable effort was expended to identify a more reliable estimate, it was determined that the MM Dillon information was the best available at this time. This is considered a major limitation on the accuracy of this section of the study. Quality data for regulated pollutants in chemical sector wastewater were obtained from the USEPA Development Documents, and residuals were estimated based on removal of regulated parameters only. These estimates do not take into account incremental residual generation resulting from removal of conventional parameters during treatment.

MAIN FINDINGS

The main findings of this study are as follows:

1. Direct dischargers in the iron and steel sector are the industry group on which MISA is estimated to have the

most significant impact. It is estimated that 0-11 tonnes of metal hydroxide sludge, may be produced as a result of MISA implementation. All of this is considered subject waste. It is further estimated that 27,700-28,300 tonnes of ferric hydroxide solids, and 12,300-27,100 tonnes of clarifier sludge would be produced as a result of MISA implementation. Assuming that all of these wastes may be contaminated with oil, grease, miscellaneous metals and organics, it has been assumed that 50% of the above totals could be subject waste.

2. MISA impact on direct dischargers in the metal finishing sector is expected to be minimal, producing an additional 7-20 tonnes per year of metal hydroxide sludge, all of which is subject waste.

3. MISA impact on indirect dischargers in the metal finishing sector is estimated to produce an incremental 900-2,000 tonnes per year of metal hydroxide sludge, all of which is considered subject waste.

4. Based on 1986 IMIS data, MISA impact on direct dischargers in the metal casting sector is estimated to generate an additional 9,500-10,800 tonnes per year of clarifier sludge, of which 50% (ie. 4,800-5,400 tonnes) could be subject waste. These estimates do not take into account potential reductions in loading resulting from treatment plants installed at two major facilities in 1987 and are <u>overestimates</u> which should be revised when 1987 IMIS data becomes available.

5. MISA impact on the organic chemical direct dischargers is estimated to generate 550 tonnes of metal hydroxide sludge, all of which would be subject waste, and 6,000-

7,400 tonnes of clarifier sludge, and estimated 50% (ie. 3,000-3,700 tonnes) of which may be subject waste.

6. MISA impact on inorganic chemical direct dischargers is estimated at 1,400-1,480 tonnes of additional clarifier sludge, an estimated 700-740 tonnes (50%) of which may be subject waste.

7. Based on removal of regulated pollutants only, MISA is estimated to generate an additional 1,500-3,000 tonnes of metal hydroxide sludge from the organic and inorganic chemical indirect dischargers. All of this estimated quantity would be subject waste. Most treatment requirements in this sector are expected to be met by process changes and granular activated carbon treatment rather than by end of pipe treatment.

8. A review of available data on the impacts of U.S. pretreatment programs on hazardous waste generation by the electroplating/metal finishing sector suggests an initial increase in sludge generation as companies comply with treatment requirements, followed by a decline in the quantities of waste disposed, as the economics of sludge disposal encourage increased 4 R's and onsite treatment.

RECOMMENDATIONS

This report should be updated when the 1987 IMIS data becomes available, when the effluent requirements under MISA are better defined, and when the numbers of indirect dischargers in various industry sectors are identified, along with the wastewater quantities and quality produced.

Chapter 1
INTRODUCTION

This chapter includes descriptions of the purpose of the study, and of the report structure.

1.1 BACKGROUND

The Ontario Waste Management Corporation (OWMC) was established as a provincial Crown Agency in 1981 with a mandate for the implementation of a province-wide program for the management of hazardous and liquid industrial waste as currently defined in Regulation 309 and referred to as "subject waste" or simply "waste" in this study.

A critical component of the OWMC FDP (Facilities Development Program) involved the assessment of the types and quantities of subject wastes generated in Ontario. The assessment data will be used to support planning of waste management facilities to be built by OWMC, and also of programs that will affect the generation and management of waste, such as encouragement of recovery, recycling and re-use practices.

1.2 OBJECTIVES

As part of the data collection effort, VHB Consulting retained CANVIRO Consultants on behalf of the OWMC to undertake a study to estimate the quantities of subject wastes potentially generated in Ontario as a result of implementation of the MISA (Municipal and Industrial Strategy for Abatement) program. The study focussed on the industry groups most likely to impact on hazardous waste generation

from treatment of wastewaters. These were considered to be direct dischargers in the iron and steel, organic an inorganic chemical, metal casting and metal finishing sectors, and indirect dischargers in the metal finishing and organic and inorganic sectors. An analysis was also carried out of available data on the changes in hazardous waste generated by the metal finishing sector in selected jurisdictions in the U.S. as a result of implementation of pretreatment programs.

1.3 REPORT STRUCTURE

The methodology employed in conducting the study is described in Chapter 2. Chapters 3 and 4 discuss estimates of incremental wastewater treatment residuals generated by the metal finishing and chemical sectors. Chapter 5 presents estimates for the direct dischargers in the iron and steel and metal casting sectors. Chapter 6 presents a review of data obtained on changes in hazardous waste generation as a result of implementation of pretreatment programs in the U.S. Conclusions and recommendations derived from the study are presented in Chapter 7.

Chapter 2
STUDY METHODOLOGY

This chapter describes development of the study methodology, and the sources of information consulted and used during development of the estimates.

2.1 SCOPE OF STUDY

2.1.1 GENERAL DESCRIPTION OF MISA

The Ontario Ministry of the Environment MISA (Municipal and Industrial Strategy for Abatement) program is an ambitious program aimed at the virtual elimination of the discharge of toxic substances to the environment. The program focuses on three major sources of toxic discharges, namely:

i) Direct Industrial Dischargers, who currently discharge wastewaters to open watercourses and who will be controlled in the future by Industrial Regulations.

ii) Indirect industrial dischargers who discharge to municipal sanitary sewers and who will be regulated by the proposed sewer use control program.

iii) Municipal sewage treatment plants who will be controlled by the proposed municipal water pollution control plant regulations.

Household hazardous waste generation is also addressed under the MISA program, but is not addressed in the present study. Estimates of household hazardous wastes generated in Ontario are presented in CANVIRO (1988).

2.1.2 DIRECT DISCHARGERS

The MISA program initially focussed on ten categories of direct dischargers namely:

- Petroleum Refining (7 Refineries)
- Organic Chemical Manufacturing (19 Plants)
- Pulp and Paper (27 Mills)
- Mining Industry
- Mineral Industry (2000 Producing & Potential Facilities)
- Iron and Steel (7 Establishments)
- Electric Power Generation (6 Thermal, 3 Nuclear, 68 Hydroelectric)
- Inorganic Chemicals (21 Facilities)
- Metal Casting (50 Establishments)
- Municipal Sector (400 Sewage Treatment Plants)

Each industrial sector and the municipal sector pass through three main stages of the MISA program. First, each sector conducts initial sampling and analysis as part of its pre-regulation and monitoring program. Secondly, each must comply with the monitoring regulation, which lasts for 12 months, and is imposed on the sector after analysis of the pre-monitoring results. Finally, an abatement regulation is imposed. Each of these phases includes involvement of joint technical committees comprised of representatives from MOE, Environment Canada and the industry involved. The status of each sector at the time of writing (October 1988) is summarized in Table 2.1.

Each MISA sector specialist was contacted as the outset of this study to ascertain if MISA implementation on their sector was considered likely to generate significant quantities of subject waste. Based on preliminary discussions summarized in Table 2.1, the study was limited to direct dischargers in the following sectors:

Table 2.1

SUMMARY OF MISA STATUS AND POTENTIAL IMPACT ON DIRECT DISCHARGERS

Sector	Status	Preliminary Assessment of MISA Impact on Residual Generation
Petroleum Refining	Monitoring Regulation promulgated Initial reports due Sept. 1988 Initial Monitoring due Dec. 1988 Limits compliance regulation 1990	Sector considered close to BAT. Incremental residuals expected to be minimal.
Organic Chemical Manufacturing	Monitoring Regulation promulgated Feb. 1989 Limits compliance regulation 1991	Generation of incremental subject waste residuals expected.
Pulp & Paper	Monitoring Regulation March 1989 Limits compliance regulation 1991	Generation of significant residuals expected - not likely to be subject waste.
Industrial Minerals	At preliminary stages. Last sector to come online	Involves cement, salt, chalk, etc. Residuals generated not likely to be hazardous.
Iron & Steel	Monitoring Regulation 1989 Limits compliance regulation 1991	Generation of incremental residuals expected.
Electrical Power Generation	Pre-regulation monitoring complete. Monitoring regulation likely late 1989 Limits compliance regulation likely 1992	Generation of incremental residuals unlikely - sector discharges cooling water mostly.
Inorganic Chemical	Working on draft regulation. Monitoring regulation mid-1989 Limits compliance regulation 1992	Generation of incremental residuals expected.
Metal Casting	Working on draft regulation. Monitoring regulation mid-1989 Limits compliance regulation 1992	Generation of incremental residuals by a few large companies expected.
Mining	Monitoring regulation early 1989 Limits compliance 1991	Any residuals would definitely remain onsite.
Municipal Sector	Working on draft regulation. Monitoring regulation 1990/1992	Residuals not expected to be subject waste.
Sewer Use	Discussion Paper released for Public comment	

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i) Iron and Steel
ii) Organic Chemical Manufacturing
iii) Inorganic Chemical Manufacturing
iv) Metal Casting

The seven metal finishing companies for which data was available in the IMIS database were also included in the study.

Because of the sensitive nature of the MISA program and the favourable co-operation received by the MOE from industries so far, the MOE asked that companies involved not be contacted by CANVIRO directly as part of the present study. For this reason, if clarification was required on any point, this was carried out through discussions with local MOE personnel.

2.1.3 INDIRECT DISCHARGERS

The major focus of the MISA sewer use control program will be to minimize discharge of toxic contaminants to municipal sewers. Discussions with industrial waste treatment experts, and also consultants familiar with implementation of pretreatment programs in the U.S. indicated that electroplaters and metal finishers are generally significantly impacted by implementation of such programs. On the basis of these discussions it was decided that indirect dischargers involved in metal finishing operations should be included in the present study.

An extensive study carried out by the USEPA identified both the metal finishing and the chemical sector as significant dischargers of priority pollutants to sewage treatment plants in the U.S. The recently released MISA discussion paper, "Controlling Industrial Discharges to Sewers", identifies the fabricated metal products and organic chemical

sectors as significant sources of toxic contaminants. Based on the above comments, the chemical sector (indirect dischargers) were included in the present study.

The precise format of the proposed MISA sewer use control program was still in development at the time of writing (October 1988). However, for the purpose of this study it was assumed that it would be similar to PSES limits set by the USEPA for the Metal Finishing Sector (Federal Register 1983) the Inorganic Chemical Sector (Federal Register 1984) and the Organic Chemical Sector (Federal Register November 1987).

2.2 SOURCES OF DATA BY TOPIC

2.2.1 IDENTIFICATION OF NUMBER OF ESTABLISHMENTS IN EACH GROUP

Direct Dischargers

The number of direct dischargers in each sector was taken as the number of companies identified in the MOE IMIS database. The 1986 data (published October 1987) was the most recent data available at the time of writing, and was the main reference used for this study.

Indirect Dischargers

The number of metal finishers in Ontario was identified through discussions with members of Environment Canada staff who have had significant involvement with this industry group, and also from a 1984 Environment Canada report on the surface finishing industry in Canada.

The number of indirect dischargers in the chemical sector was obtained from an M.M. Dillon report "Evaluation of Municipal Sewer Use Control Options - Phase I" (1987). This was a best estimate based on factors developed from USEPA "Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works (The Domestic Sewage Study) (1986)", and is considered approximate only. The CCPA (Canadian Chemical Producers Association) was contacted, but did not have data on this topic.

A number of municipalities were contacted as part of this study to obtain data on the number of indirect dischargers in various industry groups discharging to their sewers. The data is apparently being organized as part of MISA, but was not available to CANVIRO at the time of the study.

2.2.2 EFFLUENT QUALITY DISCHARGED

Direct Dischargers

Data on effluent quality discharged was taken from the 1986 MOE IMIS database.

Indirect Dischargers

Data on effluent quality discharged by metal finishers was obtained from the Environment Canada database generated during the 1983-1984 survey of the Canadian surface finishing industry.

Data on effluent quality discharged by the chemical industry was not available, hence preliminary estimates were based on quality data for regulated pollutants only obtained in the USEPA Development Documents for the Chemical Sector. A number of Ontario municipalities were contacted on this topic, but would not release any data.

2.2.3 LIKELY MISA LIMITS ON DIRECT DISCHARGERS

Development of the estimates contained in this study was hampered by the fact that the specific effluent limitations which will be set by MISA are not available at this time. The pre-monitoring programs which are carried out prior to the monitoring regulations on each sector were underway or in the early stages for most of the sectors of interest when the present study was carried out in summer 1988, therefore data and decisions which would be of great interest and assistance to the study would not be available for approximately 18 months.

For this reason, assumptions had to be made on the likely or potential format of MISA. In all cases similar programs in the U.S. were used as a model, and in some cases these were modified to reflect a likely scenario for Ontario. A number of estimates of potential MISA impact were carried out for each sector as follows:

i) It was assumed that MISA would be similar to U.S. programs and that BAT (Best Available Technology) would be installed at the end of the pipe, to treat process wastewater streams. BAT effluent limitations were obtained from the Federal Register Ruling for each industry.

ii) Current effluent loading data for each direct discharger was obtained from the 1986 IMIS database. Information on the proportion of total flow which was process related was obtained from local MOE personnel.

iii) Where USEPA effluent limitations were production based, crude estimates were carried out using the sector production data readily available in public documents.

iv) It was assumed that very large industrial facilities (e.g. iron and steel) operated 365 days per year. Smaller facilities were assumed to operate 250 days per year.

v) All residuals were assumed to be dewatered to 20% solids.

vi) Estimates were developed on the residuals which would be produced if total removal of currently monitored parameters were required. It was assumed that this would be achieved by conventional technology. This estimate provided an upper bound on the quantity of incremental wastewater treatment residual which could be produced based on currently available effluent loading information.

vii) Residual estimates were developed assuming that MISA might require production of 15:15:15 or 25:25:15 effluents for TSS:BOD (or COD): oil and grease respectively from BAT systems. These effluent quality assumptions were often more stringent than USEPA effluent limitations, but were used to provide a range of estimates, and also to test the sensitivity of residual production with respect to required effluent quality.

viii) Estimates were developed assuming that MISA might require a 15:15:15 concentration on total plant effluent, including all cooling water flows. This assumed limitations similar to current storm sewer use by-laws.

ix) For all of the above estimates current loadings for monitored parameters were taken from the IMIS database and subtracted from proposed loading limits to obtain a quantity of dry solids removed. Assumptions on the soluble and particulate content of various monitored parameters are outlined in the text.

2.2.4 LIKELY MISA LIMITS ON INDIRECT DISCHARGERS

MISA limits on indirect dischargers in Ontario were assumed to be similar to the PSES limits set by the USEPA for metal finishers (1980) and the chemical sector (1984, 1987).

2.2.5 IMPACT OF U.S. PRETREATMENT STANDARDS ON HAZARDOUS WASTE GENERATION

Available data on manifested F006 waste was obtained for a number of U.S. jurisdictions, but was found to contain numerous errors and was therefore considered unreliable. Detailed data were then obtained for six companies which form part of the Milwaukee Pretreatment program, and trends in these data over a five year period, (prior to and after pretreatment standard implementation) were assessed.

2.3 ADDITIONAL PROFESSIONAL INPUT

A study of this nature required extensive discussions with professionals who have experience with similar programs, or who have particular expertise related to specific industrial groups. A number of these are described below. A list of people contacted to discuss the present study is included in Appendix C.

MOE MISA group

Each of the sector specialists in the MISA group were contacted during the course of the study to determine the status of MISA for their group, the status of industry specific data collected by their group, their feelings on what format MISA might take for their industry group, whether the US experience was a good model to use for the same industry in Ontario, etc.

Canadian Association of Metal Finishers

The Canadian Association of Metal Finishers (CAMF) was contacted during the course of the study to ascertain how many metal finishers were estimated to be in the Province, what the status of wastewater treatment was for this sector, how much the status of wastewater treatment had changed since the 1983 Environment Canada Survey, what 4 R's measures were currently in place, or were gaining popularity with metal finishers in the province, and also to discuss any other trends which might impact MISA and this industry.

Canadian Chemical Producers Association (CCPA)

The Canadian Chemical Producers Association (CCPA) was contacted to obtain any available data on the chemical sector in Ontario to help characterize the industry. The status of wastewater treatment in the industry was discussed and also any studies carried out on the industry to date.

USEPA Representatives

Members of the USEPA were contacted to discuss development of the Pretreatment standards for various industry groups, the level of success with implementation of these, development of BAT (Best Available Technology) and the level of

wastewater treatment at various industries prior to implementation of the standards. The impacts of pretreatment standards on hazardous sludge generation were also discussed.

Other U.S. State Personnel

Personnel from a number of U.S. States (in particular Wisconsin, Michigan, New York, Minnesota) were contacted to discuss the impacts of implementation of pretreatment standards on hazardous wastes generated in their jurisdictions. Questions focussed primarily on the impacts on metal bearing sludges produced by metal finishers since 1984 when the pretreatment standards for this group came into effect.

Environment Canada

Environment Canada staff were contacted to obtain detailed information from the database developed following a national survey of metal finishers in Canada in 1984. Some EPS members have had extensive dealings with metal finishers in the Province, holding workshops etc. on waste treatment and disposal. Their qualitative estimate of the status of the industry was used in subsequent estimates. Discussions were also held on the status of the chemical sector, however less work has been done on this topic, and a minimal amount of data was available.

MOE District Offices

MOE District offices were contacted to obtain additional data on some companies in the IMIS database.

Municipalities

Considerable effort was expended contacting a number of municipalities in the Province to obtain data on the number of indirect dischargers contributing flow to their sewer systems. In most cases the data was being collected and organized but was not available to CANVIRO at the time of the study. Data on effluent quality discharged to sewers by companies in the metal finishing and chemical sectors was also requested, but was not provided.

Other Consultants

Other consultants involved in work related to the present study were contacted to obtain data and/or professional opinions on related topics. These included members of MM Dillon, Ontario Research Foundation (ORF) and CH2M HILL staff.

CHAPTER 3
METAL FINISHING SECTOR

This chapter addresses the potential impacts of MISA implementation, with respect to generation of wastewater treatment residuals, on both the indirect and direct dischargers in the metal finishing sector.

3.1 GENERAL

The metal finishing industry is considered to be one of the sectors on which the impact of MISA could be significant. A profile of the metal and surface finishing industry in Canada is provided in Table 3.1. A detailed description of the type of surface finishing carried out in each of the segments in Table 3.1 is provided in a report by Environment Canada and Hanna (1984).

The SIC groupings in which metal finishing operations in Ontario are found are outlined in Table 3.2. A description of the types of metal finishing operations carried out in Ontario is summarized in Table 3.3.

There are two types of metal finishing operations, namely captive shops related to one particular industry (e.g. automotive) or job shops, which carry out work for a number of customers. Subsequent discussions address both types of operations.

Table 3.1
PROFILE OF SURFACE FINISHING SECTOR IN CANADA

	Percent of Market (dollars)
Automotive	26.0
Steel & strip mills	14.0
Hardware	12.0
Appliance	10.0
Wire goods	10.0
Plumbing	10.0
Electrical apparatus	6.0
Furniture	5.0
Pole hardware & heavy steel Construction industry	5.0
Electronics	4.0
Engine & worn parts for chrome or electroless nickel buildup	2.0
Flatware & hollowware	0.5
Jewellery	0.5

Table 3.2
BREAKDOWN OF METAL FINISHING INDUSTRY
BY CANADIAN SIC

Major SIC	SIC Description	Number of Companies in Ontario
29	Primary metal	10
30	Fabricated metal	142
31	Machinery	10
32	Transportation equipment	35
33	Electrical	74
39	Other Manufacturing	25
	Total	296*

Source: "Overview Assessment of the Canadian Surface Finishing Industry", Environment Canada and J.E. Hanna Associates Inc., 1984.

*Discussions with industry sources indicate an estimated 800 metal finishing companies in the Province.

Table 3.3
TYPES OF PROCESSES REPORTED BY METAL FINISHERS IN ONTARIO

Process	Number of Companies Reporting Process Onsite
Electroplating	
Brass	41
Cadmium	32
Chromium	99
Copper	96
Gold	20
Nickel	165
Rhodium	7
Silver	26
Tin	25
Tin lead	6
Zinc	74
Anodizing - Sulphuric	27
Anodizing - Chromic	6
Electropolishing	7
Electrolytic stripping	30
Electroless	
Brass	1
Chromium	2
Copper	17
Nickel	13
Silver	2
Tin	6
Galvanizing - Aluminum	2
Galvanizing - Tin	3
Galvanizing - Zinc	9

Reference: "Overview Assessment of the Canadian Surface Finishing Industry - Status of the Industry and Measures for Pollution Control". Environment Canada, Chemical Industries Division and J.E. Hanna Associates Inc. (1984).

3.1.1 WASTEWATER TREATMENT IN THE METAL FINISHING SECTOR

There are three main sources of wastewater from metal finishing operations:

- contaminated rinsewaters,
- periodic concentrated bath solution dumping, and
- accidental spills or leaks.

Wastewater treatment typically focuses on the rinsewaters. The concentrated acid baths are treated in the batch mode, generally by hydroxide precipitation. The supernatent may be discharged directly or directed to the clarifier of the continuous treatment system. At this time, the majority of metal finishers in Ontario are believed to have some wastewater treatment onsite. The balance reportedly rely on dilution to reduce contaminant concentrations.

Rinsing tanks contain the drag-out from plating baths, and usually contain metal salts, acids, alkalis, and, in some cases, cyanide. The waste streams from the rinsing operations are generally segregated into three separate streams:

1. the acid/alkali stream from cleaning operations and the acid plating baths of such metals as nickel, copper and lead;

2. the cyanide waste stream from cyanide plating baths of metals such as cadmium and zinc; and

3. the chromium waste stream in the form of hexavalent chromium (Cr^{6+}).

Figure 3-1 is a schematic of a "conventional treatment" facility for electroplating wastewaters containing cadmium and cyanide in addition to other heavy metals, acids and alkalis. Conventional treatment involves the following steps:

1. the cyanide stream, if present, is oxidized to form cyanate;

2. hexavalent chromium, if present, is reduced to trivalent chromium;

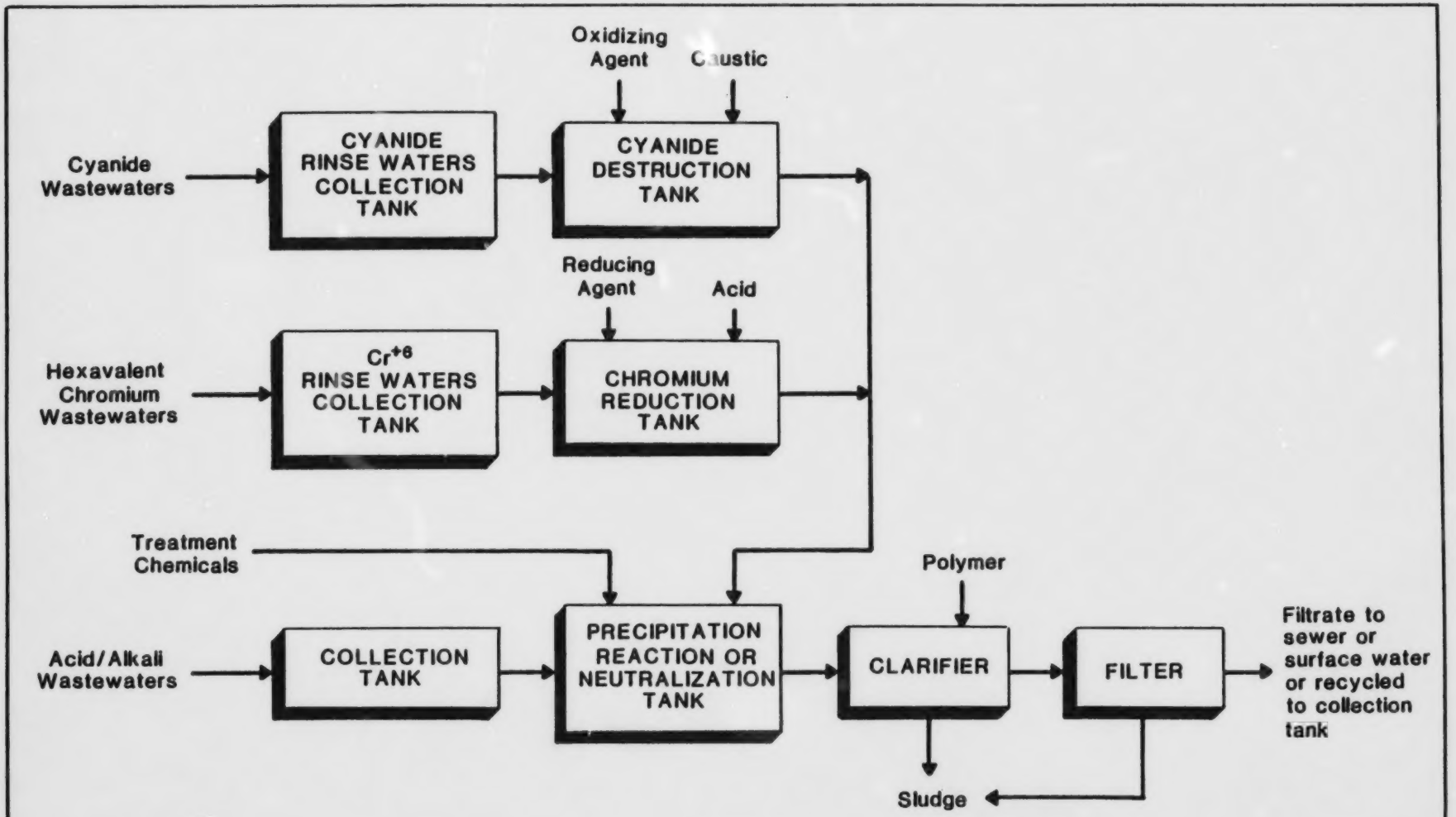

Figure 3.1

GENERAL SCHEMATIC OF A METAL FINISHING WASTEWATER TREATMENT SYSTEM

(Source: EPA/S30-SW-88-0009-1)

CANVIRO

3. the cyanide and chromium streams are then introduced into a pH control tank, together with the acid/alkali stream, to precipitate the metal hydroxides;

4. the effluent from the pH control tank is fed to a gravity settling device, usually a clarifier, where the metal hydroxides settle; and

5. the sludge from the clarifier is dewatered.

3.1.2 ASSUMED TREATMENT LEVELS REQUIRED BY MISA

For the purpose of this study it has been assumed that MISA impact on direct dischargers will require that BAT (Best Available Technology) must be provided for all process wastewaters. It has been assumed that MISA impact on indirect dischargers (who discharge to sanitary sewers) will be similar to the USEPA PSES (Pretreatment Standards for Existing Sources) and that each facility will be required to pretreat to this effluent concentration level (discussed later in the text) prior to discharge to sanitary sewers.

Although it is not explicitly stated in the U.S. Federal Register (USEPA, 1983), "conventional treatment" is considered to be BAT for the industry.

In Table 3.4 effluent levels achievable by conventional treatment are compared with the Pretreatment Standard for Existing Sources (PSES) and Best Available Technology Standard (BAT) as given in the U.S. Federal Register (1983).

It should be noted that effluent concentrations considerably lower than those indicated in Table 3.4 have been achieved by some metal finishers using conventional treatment (Patterson, 1985). Levels given in Table 3.4 are average concentrations that can be expected from normal operation.

Table 3.4
METAL FINISHING WASTEWATERS PSES, BAT AND EFFLUENT LEVELS ACHIEVABLE WITH CONVENTIONAL TREATMENT

Metal/ Contaminant	PSES Effluent Limitations (mg/L) [a]	BAT Effluent Limitations (mg/L) [a]	Effluent Levels Achievable with Conventional Treatment [b]
Cadmium	0.26	0.26	1.1
Chromium	1.71	1.71	1.0
Copper	2.07	2.07	1.0
Lead	0.43	0.43	1.5
Nickel	2.38	2.38	2.0
Zinc	1.48	1.48	0.5 - 2.0
Cyanide	0.65	0.65	0.1 - 1.0

(a) Reference: USEPA Federal Register, 1983
(b) Reference: Patterson, 1985, Environment Canada (1976, 1975).

The two metals that may be difficult to remove to the levels required by PSES are cadmium and lead. However, most of the available tertiary treatment technologies that could reduce cadmium and lead concentrations to below the PSES standard do not produce a residual (e.g. evaporative recovery). Even for technologies such as ion exchange, which would produce an incremental residual due to returning the regenerant to the conventional treatment system, or filtration which would produce a backwash, the incremental amount produced would be very small compared to that of the conventional treatment system alone. The incremental residual produced as a result of cadmium and lead removal to PSES levels has been ignored in the following analysis.

3.2 MISA IMPACT ON DIRECT DISCHARGERS

Data on metal finishing companies who discharge directly to open watercourses in Ontario was taken from the Ministry of the Environment 1986 IMIS (Industrial Monitoring Information System) database, which was the most recent publication

available at the time this report was prepared. This database provides information on flows and daily loadings of selected parameters for each of the industries monitored. A total of seven companies were included in the direct discharging category.

As illustrated in Table 3.5 the total metal loading from direct discharging metal finishers reported in the IMIS database is only about 6.2 kg per day, which translates to 1.5-2 tonnes per year, depending on the number of days of operation. Therefore, the incremental mass of wastewater treatment residual which would be produced by introducing stricter effluent standards for these companies would be 3-4 tonnes of dry solids, assuming removal all of the monitored metals and that removal of 1 tonne of metal by hydroxide precipitation produces 2 tonnes of dry solids. This would produce 15-20 tonnes of metal hydroxide sludge, assuming a 20% solids content, and 7.5-10 tonnes of metal hydroxide sludge, if dewatering to 40% solids is achieved.

Table 3.5
TOTAL EFFLUENT METAL LOADING BY DIRECT DISCHARGING METAL FINISHING COMPANIES IN ONTARIO

Company	Total Metal Loading (kg/d)
A	1.63
B	0.71
C	0.28
D	3.04
E	0.24
F	0.02
G	0.27
Total	6.19

Source: MOE 1986 IMIS Report

3.3 MISA IMPACT ON INDIRECT DISCHARGERS

3.3.1 NUMBER OF INDIRECT DISCHARGERS IN METAL FINISHING SECTOR

The survey of the Canadian surface finishing industry carried out by Environment Canada in 1984 identified 296 facilities in Ontario, of which 251 reported a discharge location, and 211 of these (i.e. 72%) reported discharge to a sanitary sewer and were therefore "indirect dischargers", as defined by this study. Subsequent discussions carried out during this study revealed that there are an estimated 800 metal finishers in the province. Results of the earlier study were used to prorate the number of indirect dischargers in the province to 84% of the total, resulting in an estimated 673 indirect dischargers in the province. This estimate is obviously open to some error, however, it was considered the most reasonable approach, based on the data available. Discussions were held with municipalities on identification of the number of companies discharging wastewater to the sanitary sewers, however, the results of these discussions did not provide adequate information with which to confirm the above estimate.

3.3.2 ESTIMATE OF INCREMENTAL RESIDUALS PRODUCED AS A RESULT OF MISA IMPLEMENTATION

Estimates of the incremental residuals produced as a result of MISA implementation on indirect dischargers has assumed that this program would be similar to the pretreatment standards imposed on metal finishers in the U.S. in 1983. Research carried out in the U.S. as part of this study, and described in Chapter 6, noted an initial sharp increase in residual production following implementation of the pretreatment standard. This was attributed to the fact that all companies who formerly did not have pretreatment systems

in place at their facilities reportedly installed treatment systems, and began to generate wastewater treatment residuals. Over time, the quantities of residuals manifested appear to have decreased. It is suspected that this trend has developed as a result of increasing recycle/reuse/recovery/reduction efforts. If a similar program is implemented in Ontario, it will require that a pretreatment system be installed at each facility discharging to a sanitary sewer. It was assumed that this would involve installation to a "conventional treatment" system as described earlier in the text at every metal finishing facility. Where a conventional treatment system is in place and effluent concentrations do not meet PSES levels, it was assumed that operation would be improved to meet these levels, with production of a small additional quantity of wastewater treatment residual. The estimates developed draw heavily on the results of the 1984 survey of the metal finishing industry in Canada carried out by Environment Canada. In some cases the results have been modified where possible to reflect information obtained through personal communication with experts in this area, including other consultants and Environment Canada staff.

Two methodologies were used to calculate incremental wastewater treatment residual production likely to occur as a result of MISA implementation on indirect dischargers in the metal finishing sector. The first is based on water quality data from the 1983/84 survey of metal finishers (Hanna, 1984) and the second is based on sludge production data from the same survey.

The results of the calculations are summarized in Table 3.6. The basis for the calculations is presented in detail in Appendix B.

Table 3.6
ESTIMATED INCREMENTAL RESIDUAL PRODUCTION FOR METAL FINISHERS IN ONTARIO AS A RESULT OF MISA IMPLEMENTATION

Methodology	Incremental Mass of Dry Solids Produced (tonnes/year)	Incremental Mass of Sludge Produced at 20% Solids (tonnes/year)	Incremental Mass of Sludge Produced at 40% Solids (tonnes/year)
A1 - Based on water quality data using NaOH for pH adjustment	440	2200	1100
A2 - Based on water quality data using lime for pH adjustment	560	2800	1400
B1 - Based on sludge production data assuming no treatment systems installed since 1983	550	2740	1370
B2 - Based on sludge production data assuming 70% of companies have treatment systems in place	360	1800	900

Metal hydroxide sludge is generally the most significant wastewater treatment residual produced by the metal finishing industry. In accordance with Regulation 309 (MOE, R.R.O., 1980), sludges produced from electroplating operations are considered as hazardous wastes, with certain exceptions. The main exceptions are sludges from tin, zinc and aluminum plating on carbon steel. However, a review of 116 of the 1983/84 respondents that provided information on effluent quality indicated that an insignificant number of metal finishers are involved exclusively in these types of plating. It was assumed for this study that other metals would also be present in the wastewaters from these operations and hence, the residuals would be considered hazardous. Each methodology is discussed briefly below.

Method A - Based on Water Quality Data

Data on metal concentrations and flow rates from 87 companies were obtained from the Environment Canada survey database. The amount of metal that must be removed by each company in order to meet the PSES standard was calculated,

by the difference between the reported metal concentrations found in the survey database and the PSES standard. Knowing the flow rate and the amount of metal that must be removed, the incremental mass of metal precipitated by conventional treatment was calculated. Precipitation factors were used to convert the mass of metal precipitated to an incremental mass of dry solids produced for each metal.

The sum of the incremental mass of residual dry solids produced by 87 companies was estimated at 56.9 tonnes, assuming hydroxide precipitation. This was extrapolated to estimate the amount of incremental sludge which would be produced by the estimated 673 indirect dischargers to a total of 440 tonnes of dry solids per year. The total mass of incremental solids estimated was then converted to a wet basis assuming a solids content range of 20-40 percent by weight, to provide an estimate of 1,100 to 2,200 tonnes of incremental metal hydroxide generated as a result of MISA implementation.

A similar exercise was carried out assuming lime would be used for metal precipitation. The results of this analysis indicate an estimated 1,400-2,800 tonnes of residual production as a result of MISA implementation. However, it is not anticipated that lime would be used for this purpose in the future, as it generates larger volumes of sludge for disposal, and hydroxide precipitation is the more popular technology of this time.

Limitations of Method A Estimate

The limitations of these calculations are as follows:

i) It has been assumed that data obtained from the 87 companies who provided water quality information is typical of the waste water quality and quantity discharged

by the total estimated population size of 673 companies. An attempt was made to determine if the 87 companies who responded to the water quality section of the questionnaire were typical of the 211 companies who identified themselves as indirect dischargers in the survey. However, it was not possible to obtain the data required to make this determination.

ii) It was not possible to confirm if the results of the 1984 survey, which covered 293 companies in Ontario were representative of the estimated total population 800 companies. The 1984 survey is the most recent data available, and has not been updated to confirm this assumption, hence, in the absence of better data, it was assumed to be representative for the purpose of this study.

iii) It was assumed that the 87 companies were representative of the 673 indirect dischargers and that no additional treatment systems had been installed since 1983. This is considered unlikely, however, it was difficult to factor in the impact of additional treatment systems in the calculation based on water quality data, therefore the potential increase in the number of treatment systems installed since 1983 was taken into account in the sludge based calculations.

iv) It is considered possible that this method may actually provide an underestimate of the actual amount of incremental residual produced, as responses on which the calculation is based may have been received only from diligent companies who make some effort to treat effluent and monitor effluent quality. This would further imply that the survey data did not include "bad actors" in the industry on whom MISA would have the greatest impact. It was not considered appropriate to adjust

the data to reflect this hypothesis as there was no reliable method to make this adjustment, hence it has not been taken into consideration. If valid, this would increase calculated quantities.

Method B - Based on Sludge Production Data

The average sludge production per company was calculated, based on the survey database results. This was determined from information provided in the Hanna report on the level of treatment that companies had in place in 1983. Details of this calculation are presented in Appendix B.

It was assumed that companies that will install treatment systems will use sludge dewatering equipment to avoid paying excessive sludge disposal costs. Knowing the average sludge production for companies with sludge dewatering in place, and also the estimated number of companies that would install treatment systems, the incremental amount of sludge produced was calculated.

Two scenarios were considered, namely (i) that no additional treatment systems had been installed since 1983 when the survey was carried out and (ii) that 70% of metal finishers had treatment in place, hence only 30% would install treatment systems as a result of MISA. The two scenarios give estimates ranging from 360-550 tonnes per year of dry solids, which result in a range of 1,800-2,700 tonnes per year of incremental waste assuming a 20% solids content, and 900-1,370 tonnes per year assuming a 40% solids content. Method No. B2 which estimates 900-1,800 wet tonnes of additional waste per year is probably more realistic. The data on which these calculations are based are limited, and may result in underestimates of incremental waste production, if it is assumed that "bad actors" did not respond to the survey and are not covered in the data.

3.3.3 DISCUSSION OF RESULTS

In both calculation methodologies, it was assumed that metal finishers will install treatment systems as a direct result of the MISA implementation requirements. Stricter surveillance by sewage treatment plants, stricter local by-laws and increasing waste disposal costs may also contribute to a company's decision to install treatment facilities before MISA implementation.

One of the major limitations of both calculation procedures is the necessity to extrapolate from data on a limited number of companies. In the calculation using water quality data, information on 87 companies is extrapolated directly to cover an estimated population of 673 companies. In the sludge production based calculation, information on 124 companies is extrapolated to determine sludge production for the metal finishers that discharge to the sanitary sewer. There is no conclusive evidence available at this time to determine whether these companies are representative of the total. However, for the purpose of this study, and in the absence of better data, it has been assumed that this is the case.

It is possible that the survey database does not include responses from the "bad actors" in the industry, on whom MISA would have the greatest impact. If this is the case, then the estimates developed are underestimates of the total impact of MISA.

Four methods were used to estimate likely impacts of MISA implementation. Methods A1 and B2 are considered more realistic and provide a range of 360-400 tonnes of dry solids resulting in an estimated 900-2,200 tonnes of metal hydroxide sludge, if a 20-40% solids content is assumed.

The calculations do not account for a reduction in sludge production that could result from the installation of sludge drying equipment or the selling of sludge to firms that attempt to recover metals from the sludge. The drying and selling of sludge are not expected to have a significant impact on the final results, however, as few companies practice this sludge handling method.

3.4 IMPACT OF 4 R'S AND ADVANCED TREATMENT ON INCREMENTAL SLUDGE PRODUCTION

The term "advanced treatment technologies" refers to processes that may be used in place of, or in addition to, conventional treatment. These processes can generally be classified into four categories:

- In-plant or process changes
- Substitute technologies
- Resource recovery techniques
- Polishing techniques

In-plant, or process changes, are alterations that can be made to an existing conventional treatment plant in order to reduce the use of water, chemicals, and/or plating metals without incurring substantial costs. Examples include: water conservation programs, such as countercurrent rinsing; material substitutions such as zinc for cadmium; techniques to reduce drag-out losses; using minimum process bath chemical concentrations; and improving operation and maintenance procedures (USEPA, 1984).

Substitute technologies refer to processes that may be used in place of one or more of the conventional treatment processes. These are usually more applicable in the design of

new plants. Examples include: the use of sulphide precipitation or sodium borohydride precipitation to replace hydroxide precipitation; microfiltration or ultrafiltration to replace clarification; and ozone oxidation or thermal oxidation to replace alkaline chlorination of cyanide (Sittig, 1978; Cushnie, 1985).

Recovery technologies are those that recover purified water and/or metal salts which can be recirculated to the rinsing tanks and plating baths, respectively. Examples include: ion exchange; evaporative recovery; reverse osmosis; electrodialysis; electrowinning; and insoluble starch xanthate liquid ion exchange (Sitting, 1978; Cushnie, 1985).

Polishing techniques are those that are applied to the effluent of conventional treatment systems. The intent of such systems is to reduce the metal concentrations beyond those achievable with conventional treatment alone. Due to the mixed nature of the effluent, no attempt is usually made with this type of system to recover metal salts. The principal technologies used in effluent polishing are ion exchange, microfiltration and ultrafiltration (Sittig, 1978; Cushnie, 1985; USEPA, 1979).

The technologies that could have the most significant impact on incremental residual production as a result of MISA implementation are the resource recovery technologies. The specific resource recovery technologies that have found applications in Ontario are evaporation, ion exchange and electrolytic processes. Electrodialysis and reverse osmosis have found limited application (Forrestal, 1987).

Metal finishing wastewaters are segregated into separate streams. Resource recovery equipment is generally utilized on one or more of these segregated streams. Their inclusion

in the treatment facility does not result in the elimination of the need for conventional treatment. However, by eliminating one or more of the metals from the conventional treatment systems, the volume of metal hydroxide sludge can be reduced.

The presence of resource recovery equipment in Ontario plants has increased in the last 10-15 years, as illustrated by results of various surveys:

No. of companies with resource recovery equipment in 1973 = 14 of 141 respondents (Envir. Can., 1975)
= 10% of respondents

No. of companies with resource recovery equipment in 1983 = 54 of 296 respondents (Hanna, 1984)
= 15% of respondents

Experience in other jurisdictions indicates a general downward trend in sludge production following implementation of pretreatment standards on metal finishers attributed to process changes, resource recovery, onsite treatment etc. It was not possible to develop a numerical value for this decrease from the data available (see chapter 6 for details). However, when more data becomes available, it may be possible to quantify this decrease and apply it to an Ontario setting.

Table 3.7 condenses information obtained from a U.S. Congressional Budget Office Report published in 1985. A clear downward trend was predicted in this study for wastes produced by the metal finishing sector. It is not clear from the study text if the projections took into account anticipated increases in waste generation as a result of implementation of pretreatment standards on metal finishers, which took place in the U.S. in 1984.

Table 3.7
ESTIMATED CHANGES IN WASTE GENERATION PATTERNS FOR METAL FINISHING RELATED WASTES
1983 AND 1990
(in thousands of metric tons)

Waste Type	Quantity in 1983	1990 Quantity with No Waste Reduction	1990 Quantity with Waste Reduction	Percent Change in 1990 Due to Waste Reduction
Metal-containing liquids	19,760	19,983	5,995	-69.7
Metal-containing sludge	14,497	15,147	13,632	- 6.0
Cyanide & metal liquids	7,383	7,284	1,821	-75.3
Cyanide & metal sludge	557	593	505	- 9.3
Total	42,197	43,007	21,953	-48%

Source: U.S. Congressional Budget Office. "Hazardous Waste Management: Recent Changes and Policy Alternative", 1985 (Table 12).

The summary indicates an estimated 6% decrease in metal containing sludge and an estimated 9% decrease in cyanide and metal sludge between 1983 and 1990, due to waste reduction measures. This estimated decrease could be applied to total waste quantities produced in Ontario.

Chapter 4
CHEMICAL SECTOR

This chapter addresses the potential impacts of MISA on direct and indirect dischargers in the organic and inorganic chemical sectors.

4.1 GENERAL

Discussions with the MOE MISA chemical sector specialists indicated that MISA implementation was expected to produce incremental residuals from both the organic and inorganic direct dischargers. The USEPA "Report to Congress on the Discharge of Hazardous Wastes to Publically owned Treatment works (The Domestic Sewage Study) (1986)" identified the chemical sector as a significant contributor of toxic pollutants to water pollution control plants. It was considered possible that the same is true for the chemical industry in Ontario, hence indirect dischargers in the chemical sector were identified as a group on which MISA implementation could have a significant effect. The MISA Sewer Use Discussion Paper released at the end of September 1988, suggests pre-treatment requirements for the chemical sector in Ontario may be implemented by 1991-1993. Preliminary estimates of MISA impact, and the assumptions on which they are based, are contained in the following sections.

4.2 DIRECT DISCHARGERS IN THE ORGANIC CHEMICAL SECTOR

4.2.1 GENERAL

The MOE 1986 IMIS database contained information on 18 direct dischargers in the organic chemical sector. TSS and BOD or TOC were monitored at each facility, and lead and zinc were each monitored at one facility. Total loadings

from the sector are 6,000 kg/day BOD and TOC, 4,924 kg/day TSS, 9 kg/day lead an 292 kg/day of zinc on a dry solids basis, assuming 250 production days per year. Estimates of MISA impact were developed for a number of scenarios, namely:

i) All measured contaminants must be removed

ii) BAT must be installed to treat all process flows

iii) Total plant effluent must meet typical storm sewer by-law concentrations.

The above scenarios generated estimates which are presented in Table 4.1. The estimates were based on the following assumptions:

i) It was assumed for preliminary calculations that each plant was a "block box" producing effluent of the quality indicated in the IMIS database. Calculations were based on the assumption that the total stream characterized in the IMIS database would be treated in one treatment system, consisting of pH adjustment for metal removal, biological treatment for BOD/TOC removal followed by clarification, which would also accomplish TSS removal. Because of the uncertainty and sensitivity of MISA at this time, detailed calculations, taking into account existing treatment systems, the possibility of stream separation etc., were not carried out. When the MISA monitoring regulation results are available, and the format of MISA is more defined, refining of these calculations would be warranted.

ii) It was assumed that biological treatment systems would be used for BOD and TOC removal, generating 0.5 kg and 1 kg of biological sludge for each kg of BOD and TOC

Table 4.1

SUMMARY OF MISA RESIDUAL ESTIMATES FOR ORGANIC CHEMICAL DIRECT DISCHARGERS

Assumption	Assumed Effluent BOD/TSS (mg/l)	Residual Description and Quantity (tonnes/yr)				
		Biological Solids	"TSS" Settled with Biological Solids	Total Clarifier Sludge (biological & TSS)	Metal Hydroxide	Total* Waste Quantity
Total removal	0/0	6,400	6,150	12,550	570	13,120
Total plant effluent meets existing storm sewer by-law	15/15	1,280	420	1,700	540	2,240
BAT on process flow						
+Best estimate	15/15	4,400	3,040	7,440	560	8,000
+Polysar low	15/15	4,640	3,430	8,070	560	8,630
+Polysar high	15/15	3,550	1,960	5,510	560	6,070
Process flows meet EPA Federal Register BAT limit	24/40 (mainly)	3,920	2,030	5,950	560	6,510
Likely Total Waste Range		see Total Clarifier Sludge Column	see Total Clarifier Sludge Column	6,000-7,440	540-560	6,540-8,000
Likely Subject Waste Range				3,000-3,700	540-560	3,540-4,260

*Assumes 250 days of production

+The "Best estimate" used a process to total IMIS recorded flow ratio of 0.09.
The "Polysar low" case used a process to total flow fraction of 0.01.
The "Polysar high" case was calculated assuming all flow reported in the IMIS database was process flow with no dilution.

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removed, respectively. Because of the limited data available, no assumptions could be made regarding the percentage of organic material associated with the TSS. In the absence of other data, it was assumed that reported BOD and TOC were all soluble, and not associated with particulate material.

iii) Removal of all contaminants was considered an unrealistic objective, but was used to generate estimates of an upper bound on residuals produced by MISA implementation. For this estimation it was assumed that the chosen technologies could remove all measured contaminants down to minimal concentrations. Polishing technologies would be required to achieve the high removals assumed. However, it was assumed for this analysis that the incremental residuals produced by these systems would be negligible, and they were ignored.

iv) It is possible that a loading limit in kg/d of various contaminants will be developed on a plant by plant basis under MISA. Again the program was not far enough advanced to estimate what this loading limit might be, hence preliminary calculations based on a storm sewer use by-law concentration limit on total plant effluent were carried out, to give a preliminary range of possible waste quantities. The concentrations in total plant effluent assumed for these estimates were:

15 mg/l	BOD or TOC
15 mg/l	TSS
1 mg/l	Lead
1 mg/l	Zinc

These concentrations were taken from a summary of eleven (11) existing municipal storm sewer use by -laws presented in Table 4.2.

Table 4.2

SUMMARY OF MUNICIPAL STORM SEWER USE BY-LAWS

Parameter	Symbol	Units	York Region	Vaughan	Richmond Hill	Markham	Borough of East York	Metro-politan Toronto	Scar-borough	North York	Toronto	Hamilton-Wentworth 1979	Waterloo 1987	MISA Model Sewer Use By-law
Aluminum	Al	mg/l	1	1	NA	1	NA	1	1	NA	1	-	1	-
Ammonia (1)	NH_3	mg/l	10	10	NA	10	NA	10	NA	NA	10	-	-	-
Arsenic	As	mg/l	1	1	NA	1	NA	1	1	NA	1	-	1	0.1
Barium	Ba	mg/l	0.1	0.1	NA	0.1	NA	1	1	NA	1	-	1	-
Cadmium	Cd	mg/l	0.1	0.1	1	0.1	NA	0.1	0.1	1	0.1	1	0.1	0.0002
Chlorine	Cl_2	mg/l	1	1	NA	1	1	1	1	NA	1	-	1	-
Chlorides	Cl	mg/l	NA	NA	1500	1500	1500	NA	NA	1500	NA	1500		
Chromium	Cr	mg/l	1	1	NA	1	NA	1	1	1	1	1	1	0.1
Copper	Cu	mg/l	1	1	1	1	5	1	1	5	1	1	1	0.005
Cyanide	HCN	mg/l	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.005
Fluoride	F	mg/l	2	2	NA	2	NA	2	2	NA	2	-	2	-
Iron	Fe	mg/l	1	1	17	1	17	1	1	17	1	17	1	-
Lead	Pb	mg/l	1	1	0.1	1	5	1	1	NA	1	1	1	0.025
Manganese	Mn	mg/l	1	1	NA	1	NA	1	1	NA	1	-	1	-
Mercury	Hg	mg/l	0.001	0.001	NA	0.001	NA	0.001	0.001	NA	0.001	-	0.001	0.0002
Nickel	Ni	mg/l	1	1	1	1	1	1	1	NA	1	1	1	0.025
Oil & grease	O&G	mg/l	15	-	-	-	-	-	-	-	-	10	15	0
Phenolic compounds		µg/l	20	20	20	20	40	20	20	40	20	20	20	1
Phosphorus	P	mg/l	1	1	NA	1	NA	1	1	NA	1	1	1	0.03
Sulphides (2)	H_2S	mg/l	NA	NA	5	NA	NA	NA	NA	NA	NA	1	1	-
Sulphates	SO_4	mg/l	NA	NA	1500	1500	1500	NA	NA	1500	NA	1500	-	-
Suspended solids		mg/l	15	15	15	15	30	15	15	30	NA	15	15	-
Tin	Sn	mg/l	1	1	NA	1	NA	1	1	NA	1	-	1	-
Zinc	Zn	mg/l	1	1	NA	1	5	1	1	5	1	3	1	0.03
Temperature		°C	65	65	65	65	65	65	65	NA	65	-	65	65
BOD		mg/l	15	15	15	15	20	15	15	20	NA	15	15	1
pH		pH	6-9.5	6-9.5	5.5-9.5	6-9.5	5.5-9.5	6-9.5	6-9.5	6-9.5	NA	-	6-9.5	-
Coliform count		counts/ 100 mL	NA	NA	2400	2400	2400	NA	2400	NA	NA	2400	2400	100

Note: (1) As N
(2) As hydrogen sulphide

(COPY/30W)

v) Estimates were also carried out assuming BAT would be required on all process streams in each plant. Local MOE personnel were contacted to determine the percentage of the reported IMIS flows which were process related for the largest plants (Dow, Dupont Maitland, Dupont Kingston, Polysar). In the case of Courtaulds, it was assumed that all flows were process related. The flows from this plant were relatively low, and contaminant loading high, hence this assumption resulted in a minimal under estimate of the residuals produced.

vi) Detailed information had not been obtained on Polysar at the time of writing, and because it was a significant contributor, estimates assuming a high, low and "best estimate" process flow percentage were developed. It was reported that most of the flow discharged by Polysar was cooling water, hence the best estimate assumes that 9% of flows reported in the IMIS database are process related.

vii) The appropriate Federal Register rulings were reviewed to determine concentration limits set for effluent from various facility types, for TSS and BOD. These levels are summarized in Table 4.3 and in some cases indicated that if MISA adopted these effluent concentrations, no additional treatment would be required at some Ontario plants. The category to which each of the 18 facilities in Ontario was assigned for this analysis is presented in Table 4.4.

viii) It was assumed that a well operated treatment system (assumed to be BAT) should be able to achieve the following effluent quality:

BOD or TOC	15 mg/l
TSS	15 mg/l

Table 4.3

COMPARISON OF USEPA BAT EFFLUENT LIMITATIONS
FOR ORGANIC CHEMICAL SECTOR SUBCATEGORIES

Sub-category Letter	Subcategory Description	Effluent Limitation Maximum Monthly Average (mg/l) BOD_5	TSS	Lead	Zinc
(B)	Rayon Fibres				
	BPT	24	40		
	BAT	24	40	0.32	1.05
(C)	Other Fibres				
	BPT	18	36		
	BAT	18	36	0.32	1.05
(D)	Thermoplastic Resins				
	BPT	24	40		
	BAT	24	40	0.32	1.05
(E)	Thermosetting Resins				
	BPT	61	67		
	BAT	61	67	0.32	1.05
(F)	Commodity Organic Chemicals				
	BPT	30	46		
	BAT	30	46	0.32	1.05
(G)	Bulk Organic Chemicals				
	BPT	34	49		
	BAT	34	47	0.32	1.05
(H)	Specialty Organic Chemicals				
	BPT	45	57		
	BAT	45	57	0.32	1.05

Source: Federal Register Part IV Environmental Protection Agency. 40 CFR Parts 414 and 416. Organic Chemicals and Plastics and Synthetic Fibers Category. Effluent limitations guidelines. Pretreatment Standards and New Source Performance Standards. Final Rule November 5, 1987.

Table 4.4

DESCRIPTION OF ORGANIC CHEMICAL DIRECT DISCHARGERS

Company	Products*	Sub-category**
Bakelite	Phenol Resins, Formaldehyde Resins	E
B.F. Goodrich	Polyvinyl Chloride	D
Borg-Warner	ABS Resins (plastics)	D
Cyanamid	Ammonia, Urea, Nitric Acid, Ammonium, Nitrate, Dicyanamide, Phosphorus Products	H
Courtaulds (BCL)	Rayon (cellulose film)	B
Celenese	Textiles (polyester fibre)	C
Cdn Oxy-Durez	Phenol-Formaldehyde Resins	E
Domtar	Detergents and Detergent Bases	H
Dow	Chlorine Related Products	G
Dupont - Kingston	Synthetic Nylon	B
- Maitland	Nylon, Plastics, Spandex, H_2O_2, Chlorofluorocarbon	G
- Corunna	Plastics	D
Esso Chemical	Polyethylene, PVC, Benzene, Toluene, Xylene	D
Ethyl Canada	Tetraethyl Lead	G
Polysar	Synthetic Rubber	D
Reichhold	Phenol-Formaldehyde Resin Urea-Formaldehyde Resin	E
Union Carbide	Polyethylene Resins	D

*Source: MOE 1986 IMIS Report

**See Table 4.3 for subcategory descriptions.

Estimates were also developed assuming the above effluent levels might be required by MISA. Lead and zinc effluent concentrations obtained in the Federal Register were considered appropriate for development of these estimate.

4.2.2 DISCUSSION OF RESULTS

Results of the analyses described are presented in Table 4.1 and indicate estimates varying from 2240 to 13,120 tonnes per year of residual for the various scenarios considered.

The "total removal scenario" indicates an estimated total of 13,120 tonnes per year of incremental wastewater treatment residuals, consisting primarily of clarifier sludge (biological and settled solids), and an estimated 570 tonnes per year of metal hydroxides.

Imposing existing storm sewer use by-law concentration limits on the total plant effluents resulted in an estimated total of 2240 tonnes of incremental residual, consisting of an estimated 540 tonnes per year of metal hydroxide, and 1700 tonnes per year of clarifier sludge.

Imposing existing EPA Federal Register BAT effluent concentrations resulted in an estimated 6510 tonnes of incremental residuals, consisting of on estimated 5950 tonnes of clarifier sludge (biological and other settled solids) and an estimated 560 tonnes of metal hydroxide sludges. Most of this hydroxide sludge would be generated by one company on the IMIS database. This estimate is subject to some variation, depending on the category into which each chemical company is placed.

Three estimates were developed assuming BAT effluent limitations on process flows could be as low as 15:15 for BOD:TSS.

The estimated totals ranged from 6100-8000 tonnes per year. Confirmation on Polysar process flows is required to firm up these estimates, and was not available at the time of writing.

It is considered likely that the clarifier sludges containing biological and miscellaneous solids would contain product from the chemical plant, and miscellaneous organics and metals picked up throughout the system. It is therefore possible that they could be classified as subject waste. Future regulations may be more stringent and sludge or leachates may be monitored for a larger number of parameters. It is too early at this stage to comment on whether these sludges would be considered subject waste. Because it is considered unreasonable to assume that none of these would be subject waste, and also unreasonable to assume that all would be, an assumption of 50% subject waste fraction has been used for this preliminary analysis, resulting in a range of 3000-3700 tonnes per year of subject waste clarifier sludges. As the regulations have only recently been implemented in the U.S. and there is a three year period to achieve compliance, it is too early to look to the U.S. experience for confirmation of this assumption.

The methodologies used estimated 540-560 tonnes of metal hydroxide sludge would be produced. This material would be subject waste.

The above estimates are based on 1986 IMIS data and do not take into consideration any changes which may have taken place at the plants since that time. They should be updated when the 1987 IMIS data becomes available, and also when the MISA program is further advanced.

4.3 DIRECT DISCHARGERS IN THE INORGANIC CHEMICAL SECTOR

4.3.1 GENERAL

Information was provided in the IMIS database on seven (7) inorganic chemical companies. TSS were monitored at all facilities, and other parameters monitored ranged from nitrogen compounds to metals, depending on the company involved. Total measured flows and loadings from this sector were lower than for other sectors, hence the impacts of MISA implementation on waste generation by the inorganic sector would appear to be less significant than for other sectors considered, based on the data available.

Preliminary estimates indicated that total removal of all contaminants would generate an estimated 2060 tonnes of clarifier sludge, up to 50% of which might be subject waste (using the same rationale developed for the organic sector). The actual impact of MISA is likely to be less than this amount, if it is assumed that the total removal scenario is unreasonably stringent.

Estimates of MISA impacts were carried out for four scenarios, namely:

i) Total removal of all contaminants

ii) Total plant effluent to meet 15 mg/l TSS

iii) BAT on process streams to meet 15:15 BOD:TSS effluent

iv) BAT on process streams to meet 25:25 BOD:TSS effluent

All calculations assumed plants operated 250 days per year. Technical assumptions on which the estimates were based are as follows:

i) Nitrogen compounds would be removed by physical/chemical processes (such as ammonia stripping) which would not produce residuals

ii) Excess TSS would be removed by sedimentation, and sludges would be dewatered to 20% solids

The USEPA Federal Register BAT limitations are based on plant chemical production rates. Plant production information was not available at the time of writing, hence allowable loading limits based on the USEPA approach were not developed.

4.3.2 DISCUSSION OF RESULTS

Results of the analysis described in the previous section are summarized in Table 4.5, and indicate a high estimate of 2060 tonnes per year and a low estimate of 470 tonnes per year of clarifier sludge. The approach based on BAT applied to process streams indicated a range of 1400-1480 tonnes per year, depending on effluent TSS requirements. This estimate did not appear to be particularly sensitive to effluent quality requirements in the range of values chosen ie. 15-25 mg/L TSS.

The sludge produced could contain an assortment of chemical compounds and possibly metals. It is difficult to comment on whether it would be a subject waste. Because of the small quantity involved, and the relative uncertainty regarding the MISA program at this time a range of 0-100% subject waste should be chosen. However, for preliminary

Table 4.5
SUMMARY OF MISA RESIDUAL ESTIMATES FOR
INORGANIC CHEMICAL DIRECT DISCHARGERS

Assumption	Assumed Effluent BOD/TSS (mg/l)	Incremental Clarifier Sludge (tonnes/year)
Total removal	0/0	2060
Removal to existing storm sewer use by-law applied to total plant effluent	15/15	470
BAT on process streams	15/15	1480
	25/25	1400
Likely Total Waste Range		1400 1480
Likely Subject Waste Range (50%)		700-740

planning purposes, it is unreasonable to assume that none, or all, of the sludge would be subject waste, hence a 50% subject waste fraction was used. This can not be confirmed at this time. The above analysis results in an estimate 700-740 tonnes per year of subject waste clarifier sludge.

These estimates are incremental to wastes produced by the inorganic chemical direct dischargers included in the IMIS database, in 1986, and do not account for any changes implemented at these plants since that time. They should be updated when the 1987 IMIS data becomes available, and also when the MISA program is further developed.

4.4 CHEMICAL SECTOR INDIRECT DISCHARGERS

4.4.1 NUMBER OF INDIRECT DISCHARGERS IN CHEMICAL SECTOR IN ONTARIO

The number of indirect dischargers in the chemical sector was estimated by M.M. Dillon and presented in a report to the MOE in 1987*. This estimate was based on numbers provided in a USEPA study for the total U.S.,** which were then downscaled to take account of Ontario's size. This estimate was considered very approximate, and other methods of developing a firmer estimate were investigated as part of the present study. A number of municipalities were contacted to obtain the number of industries in SIC 37 (Chemical Products Industries) discharging to their sewer systems. For the most part this information was not available. Reliable numbers were obtained from two municipalities (Essex and Waterloo) but were not considered adequate data with which to modify the Dillon estimate. The Canadian Chemical Producers Association (CCPA) was contacted to determine if information was available on this topic, but no additional data was obtained from this source. In the absence of better data from either municipalities or the chemical industry group, the Dillon numbers were used, as they are considered the best estimate available at this time. Information on indirect dischargers is being collected by municipalities at this time as a requirement of MISA, hence this estimate can be updated when this information becomes available. Information from the Dillon report is summarized on Table 4.6.

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* "Evaluation of Municipal Sewer use Control Options" Report to Environment Ontario by M.M. Dillon Dec. 1987.

** USEPA Report to Congress on the Discharge of Hazardous Wastes to Publically Owned Treatment Works (The Domestic Sewage Study) February 1986.

Table 4.6
ESTIMATED NUMBER OF INDIRECT DISCHARGERS AND PROCESS FLOWS
FROM ONTARIO
CHEMICAL SECTOR (SIC 37)

RCRA Class	Canadian Equivalent	Canadian SIC Code	Number of Establishments	Estimated Number of Indirect Dischargers	Estimated Flow (MIGD)	Estimated Flow m^3/d
Adhesives & Sealants		3792	21	12	0.095	431
Ink manufacturer & formulation	Primary Ink	3791	30	14	< 0.004	< 18
Inorganic		3711	35			
Chemical		3721	3			
Formulation		3722	44			
			82	13	6.5	29,510
Organic		3712	24			
Chemical		3799	161			
			185	80	18.9	85,806
Paint Manufacturer	Paint & Varnish	3751	82	41	0.04	182
Pesticide Formulation		3729	5	1	0.02	91
Pharmaceutical		3741	68	41	5.9	26,786
Plastic Resins & Synthetic Fibres		3731	42	17	1.97	8,944
TOTAL			515	219	33.429	151,768

SOURCE: "Evaluation of Municipal Sewer Use Control Options - Phase I"
Report to Environment Ontario by M.M. Dillon, December 1987

4.4.2 WASTEWATER TREATMENT REQUIREMENTS TO MEET PSES

Discussions with representatives of the Canadian Chemical Producers Association (CCPA) indicated that most of the indirect dischargers do not currently have wastewater treatment systems on site. Information obtained from municipalities was not adequate to prove or disprove this statement, hence in the absence of other data it was assumed to be accurate. Discussions were held with USEPA representatives regarding a implementation of pre-treatment standards in the U.S. PSES (Pretreatment Standards for Existing Sources) limitations for the organic chemical sector were obtained from the Federal Register (November 1987). Discussions with EPA personnel indicate that most organic chemical indirect dischargers had very little treatment in place, and that these facilities have until November 1990 to comply with the new regulation. It was felt that most of these facilities would be basically starting from scratch in terms of pretreatment installation. Biological end of pipe treatment (which is standard for the organic chemical direct dischargers) is not expected at most indirect discharging facilities. It is anticipated that they will meet PSES requirements by in-plant measures as follows:

- Steam stripping of volatiles
- Chemical precipitation of metals
- Chemical oxidation of cyanide and
- Activated carbon for removal of several parameters

No national standards were developed for conventional parameters such as TSS, BOD, etc. Discharge of conventionals is controlled by local municipalities.

Discussions regarding the inorganic chemical sector indicated that all facilities in the U.S. should now be in com-

pliance with PSES requirements which were published in the Federal Register in 1984. In-plant measures adopted by the inorganic chemical sector included:

- o Steam stripping of ammonia
- o Chemical oxidation of cyanide
- o Hydroxide precipitation of metals

Precipitation of metals is the only one of the above technologies to generate residuals of interest to this study. The USEPA official who developed the effluent guidelines commented that many inorganic chemical industries are dry, and do not generate a process wastewater.

Even though removal of conventionals is not required by US Pretreatment standards, the technologies required to remove some of the parameters of concern would also likely remove TSS from the effluent, unless careful stream separation is feasible.

Removal of TSS would be required prior to activated carbon adsorption, creating a clarifier sludge which might (or might not) contain substances of concern. Also, pH adjustment for metals removal followed by clarification would also remove TSS. Therefore, theoretical calculations based on removal of regulated parameters only (generally organics and metals) would result in an underestimate of the total residuals likely to be generated by introduction of Pretreatment standards similar to the U.S. in Ontario.

4.4.3 CALCULATION OF MISA IMPACT

Calculations were hampered by a lack of data on the quality of effluent currently discharged by chemical facilities to sanitary sewers. For this reason, two sources were used for potential quality data, namely:

i) It was assumed that existing effluent quality from chemical facilities would be similar to process effluent discharged by direct dischargers who do not have onsite treatment

ii) The USEPA development documents for the Organic Chemicals Plastics and Synthetic Fibers Point Source Category were reviewed to obtain effluent quality data with which to develop preliminary estimates.

Effluent quality data obtained in the development documents were used to estimate the quantity of residuals generated by removal of regulated parameters only. These are primarily metals and selected organics. It was assumed that the organics of concern would be removed by activated carbon adsorption, generating a residual which was not of interest to this study. The amount of activated carbon required to treat the estimated wastewater flows at concentration levels obtained in the development documents was minimal, however calculations were carried out based on regulated parameters only, and did not take adsorption of other wastewater constituents into account. For this reason these are considered underestimates.

It was assumed that removal of metals would be achieved by hydroxide precipitation, generating a metal hydroxide sludge. It is considered likely that conventional parameters might also settle with the hydroxide sludge and increase its volume considerably. Because of the orders of magnitude variation in data provided in the development documents on concentrations of parameters such as BOD and TSS in chemical plant wastewater, this data was not used because of the potentially significant error involved. Hence, TSS removal during hydroxide precipitation was not taken into account in the calculations and results are considered underestimates. The results of the analysis for the chemical sector indirect

dischargers are summarized in Table 4.7 and indicate that an estimated 1550-2950 tonnes per year of metal hydroxide, which would be subject waste, would be produced by the chemical sector indirect dischargers. This is likely an underestimate, as it does not take removal of TSS in the hydroxide precipitation system into account.

Table 4.7
SUMMARY OF MISA RESIDUAL ESTIMATES
FOR CHEMICAL SECTOR INDIRECT DISCHARGERS

Chemical Industry Type	Canadian SIC	Residual Produced (tonnes/yr)	Comments
Fertilizer	3721	0	Development documents state that this industry is not generally a water user, assume no wastewater discharge.
Pharmaceutical	3141	0	Cyanide only regulated parameter. This would be removed by oxidation producing no residual.
Inorganic	3721 3722	1300-2700	Based on U.S. data scaled down to Ontario, and removal of regulated metals only.
Organic	3741	250	Based on removal of regulated metals only.
Total		1550-2950	Metal hydroxide sludge - all subject waste.

Chapter 5
DIRECT DISCHARGERS IN THE IRON AND STEEL AND METAL CASTING SECTORS

The potential impacts of MISA on incremental wastewater treatment residuals produced by direct dischargers in the iron and steel and metal casting sectors are addressed.

5.1 GENERAL

Estimates carried out on the above sectors were limited to companies for whom data was available in the IMIS database. As the quantities estimated for the iron and steel sector were significantly larger than for other sectors a number of possible scenarios were investigated. All estimates presented are based on a number of assumptions outlined in the text, and should be revised when more detailed company specific data becomes available from the MOE MISA office site visits.

Discussions with the MISA office staff on the metal casting sector identified two significant dischargers who would likely account for most of the incremental residuals produced by this sector. Estimates were limited to these two companies only and should be updated when work on the sector is further advanced.

All estimates are based on 1986 IMIS data, and should be updated when the 1987 IMIS data becomes available.

5.2 IRON AND STEEL SECTOR

5.2.1 GENERAL

The IMIS database provided information on seven (7) direct dischargers in the iron and steel sector. Estimates carried out for this study were based on the data available from the IMIS system.

Discussions were held with the MOE MISA office sector specialists to ascertain if there was any concensus on the likely format of MISA implementation on the iron and steel sector, to provide some framework within which estimates of incremental wastewater treatment residuals could be calculated. The sector specialist felt that it was too soon to hazard a guess as to what format MISA might take. In the absence of other data, CANVIRO developed a number of scenarios to give a range of values for planning purposes. These estimates should be updated when the Iron and Steel monitoring program is further along.

The iron and steel sector discharges very large volumes of water directly to open waters each day, along with an estimated 8,000 t/year of COD, 13,800 t/year of TSS, 2,300 t/year of oil and grease and 8,150 t/year of iron, on a dry solids basis. These and all other estimates contained in this section assume 365 days per year operation for the iron and steel sector.

5.2.2 ESTIMATE BASED ON USEPA APPROACH

The USEPA Effluent Guidelines and Standards for the Iron and Steel sector are based on permitted loading of a number of parameters, based on production at a facility. These loadings are process specific, and each process (e.g. coke

making, acid pickling, hot forming, etc.) has a number of subcategories. The plant specific data required to develop loading limits (based on the USEPA approach) for each of the 7 companies in the IMIS database was not available at the time of writing, but is currently being collected by MISA office staff. However, to provide a preliminary estimate of the potential loading limit which would be allowed if the USEPA Effluent Guidelines were implemented in Ontario, a production rate of 9,000,000 tonnes/year obtained from the IMIS database was assumed to establish preliminary loading limits for the direct dischargers in Ontario. BPT for each of twelve process types was generally based on TSS and oil and grease loading limits in kg per tonne of product produced. BAT was often defined in terms of metal loading limits. The total loading limits were estimated adding both together, if TSS and oil and grease figures were not provided for BAT. This exercise should be refined when detailed flow schematics are available for each iron and steel plant.

Preliminary results of this analysis are presented in Table 5.1, and summarized in Table 5.2, and are discussed in Section 5.2.5. This analysis indicates that the direct dischargers currently discharge 13,783 tonnes per year TSS, compared to an estimated allowable 6044 tonnes per year, based on the Effluent Standards. An estimated 2285 tonnes per year of oil and grease is discharged compared to an allowable limit of 1254 tonnes per year, and 79.2 tonnes of zinc are discharged compared to an estimated allowable limit of 11.8 tonnes per year. It is stressed that the allowable limits were developed assuming industry wide processes, and must be modified at a future time when more detailed plant-specific data becomes available.

Table 5.1

PRELIMINARY ESTIMATE OF MISA RESIDUAL GENERATION
FOR IRON AND STEEL DIRECT DISCHARGERS, BASED ON USEPA
EFFLUENT GUIDELINES AND STANDARDS

Parameter	Current* Effluent Loading (dry tonnes/yr)	Estimated** Effluent Loading (dry tonnes/yr)	Estimated Removal Required (dry tonnes/yr)	Estimated*** Residual Produced (wet tonnes/yr)
TSS	13,783	6,044	7,739	38,695
Oil & Grease	2,285	1,254	1,031	5,155
Zinc	79.2	11.8	67.4	512
TOTAL	16,147.2	7,309.8	8,837.4	44,362

* From 1986 MOE IMIS database

** Using rates from USEPA Effluent Guidelines for the Iron and Steel Sector applied to a production rate of 9×10^6 tonnes/year

*** Assuming 20% solids

Table 5.2
SUMMARY OF INCREMENTAL RESIDUAL CALCULATIONS FOR
DIRECT DISCHARGERS IN THE IRON AND STEEL SECTOR

Assumption	Assumed Effluent BOD/TSS (mg/L)	Biological Solids	"TSS" (Settled With Biological Solids)	Total Clarifier Sludge (Biological & TSS)	Oil and Grease	Ferric Hydroxide	Metal Hydroxide	Total (tonnes/yr)
1. Total Removal		20,150	41,620	61,770	11,360	31,850	625	105,605
2. Existing Storm By-Law on Total Flow	15/15	11,070	1,220	12,290	0	25,870	0	38,160
3. BAT on process flow								
(a)	25/25	10,350	1,340	11,690	0	27,680	0	39,370
(b)	15/15	14,240	11,280	25,520	0	27,680	0	53,200
(c)	15/15	14,240	11,590	25,830	0	27,800	11	53,641
(d)	15/15	15,370	11,700	27,070	0	28,290	11	55,371
4. Loading based on EPA Effluent limitation		-	38,700	38,700	5,160	-	0-521	44,370
Likely Total Waste Range		See Clarifier Sludge	See Clarifier Sludge	11,700 27,100	0 0	27,700 28,300	0-11	40,000-55,000
Likely Subject Waste Range				5,800- 13,500	0	13,000- 14,000	0-11	18,000-27,500

a, b, c, d Assumed process flow to total flow ratios:

(a)		(b)		(c)		(d)	
Dofasco	0.75	Dofasco	0.75	Dofasco	0.75	Dofasco	0.75
Stelco	0.53	Stelco	0.53	Stelco	0.53	Stelco	0.53
Other	1.00	Other	1.00	Hant, Alg.T.B.	1.00	Hant.	1.00
				Other	0.5	Other	0.5

5.2.3 ESTIMATE BASED ON ASSUMED BAT CONCENTRATIONS

In the absence of plant-specific detailed process and flow data, each plant was considered a "black box" producing an effluent characterized by the IMIS database results. It was assumed for the purpose of this study that appropriate technology would be placed at the end of the pipe to remove contaminants of concern to acceptable levels, and that cooling waters would somehow be separated from process wastewaters prior to this treatment system. This is clearly a hypothetical scenario developed in the absence of better data to provide some preliminary estimates of residuals produced. It also ignores any onsite treatment systems in place at this time.

The parameters which contributed significant loading from steel plants were TSS, oil and grease, BOD, COD and iron. Preliminary calculations were based on these parameters only. Steel mills would also discharge ammonia, phenol and metals such as lead, zinc, nickel and chrome, depending on the processes onsite. However, monitoring data was not available in the IMIS system for these parameters, and they were therefore excluded from this preliminary analysis. The assumptions on which preliminary estimates were developed are listed below:

- Excessive ammonia concentrations would be treated by ammonia stripping using sodium hydroxide for pH control, hence a residual would not be produced. Steel companies have reportedly switched from lime to sodium hydroxide for pH control since waste lime from ammonia stills became a listed waste.

- Phenols and other organics will be removed in a biological system with any additional removal

accomplished by an oxidation system (such as H_2O_2 or ozone) which would not produce a residual.

- Most of the iron recorded in these wastewaters would be in particulate form, associated with the recorded TSS and that it would settle as ferric hydroxide at neutral pH (Patterson, 1985) producing 1.6 kg of solids for each kg of iron removed.

- The oil and grease would be partly associated with measured TSS, and that it would be removed by dissolved air flotation (DAF) and/or gravity settling. In the latter case, it would contaminate the ferric hydroxide solids, hence to keep streams separate, removal by DAF has been assumed for preliminary calculations, producing 1 kg of oily solids for each kg of oil and grease removed.

- Measured COD and BOD would be removed by biological oxidation, producing 0.5 kg of biological solids for each kg of BOD or COD removed. In the absence of other data, a 50% soluble BOD and COD fraction was assumed. The remaining 50% was assumed to be particulate, associated with the TSS and would be removed by sedimentation.

- Cyanide would be removed to acceptable levels by oxidation, which would not produce a residual.

- In the absence of concentration limits from the Federal Register, it is assumed that BAT applied to treat <u>process wastewaters</u> only should provide an effluent with the following characteristics:

BOD:	15 mg/l
COD:	15 mg/l
TSS:	15 mg/l
Oil & grease:	15 mg/l
Iron:	1 mg/l

The above limits have been developed based on professional judgement of what a well operated wastewater treatment system should achieve, and also limits obtained in some existing storm sewer use by-laws. This calculation was repeated assuming BOD, COD and TSS limits of 25 mg/l, to determine if less stringent effluent standards would significantly impact on the quantities of residuals produced.

- The technology required to achieve these concentration levels would vary but one potential combination could include:
  - Ammonia stripping
  - Biological & chemical oxidation of phenol
  - Biological and chemical oxidation of other organics
  - Hydroxide precipitation of metals
  - Aeration for precipitation of ferric hydroxide
  - Dissolved air flotation of oil and grease
  - Clarification of remaining solids
- Data was not available in the IMIS database on the percentage of total flow discharged by each of these facilities which was directly process related, hence local MOE offices were contacted to obtain this data for the critical companies. Discussions with personnel in the MOE Algoma district

indicate that the reported flows at the Algoma Steel Co. terminal basin are process flows and do not include non-contact cooling water. Some of the outfalls reported in the detailed IMIS data sheets obtained from the Ministry were reported as mostly cooling water with low contaminant loadings and were therefore deleted from the analysis. Discussions with personnel at the MOE Hamilton office indicated that approximately 53% of Stelco Hilton flows and 75% of Dofasco flows are process related. The other four plants contributed relatively low loadings to the total (less than 5%), hence it was assumed that varying process to total flow ratios in these cases would not have a significant impact on total estimates.

- All residuals produced by these treatment systems would be dewatered to 20% solids.

- Dewatering of ferric hydroxide sludge is reportedly difficult, and requires conditioning, generally by lime addition. It was assumed for this study that the sludge could be dewatered to 20% solids by addition of a polymer, which would add a negligible quantity to the sludge mass.

The results of this analysis are presented in Table 5.2 and discussed in Section 5.2.5.

5.2.4 ESTIMATE BASED ON TOTAL EFFLUENT CONCENTRATIONS

It was considered possible that MISA implementation might involve imposition of a concentration limit on the total effluent discharged from a facility. Two scenarios were investigated to provide a range of values for the study.

These were:

(i) All currently discharged contaminants must be removed. It is recognized that removal of all contaminants would not be possible with the technologies assumed, and that more sophisticated polishing techniques would be required; however, the error associated with this assumption is not considered significant.

(ii' Currently discharged contaminants must be removed so that total effluent meets existing storm sewer use by-laws (summarized in Table 4.2). The proposed MISA storm sewer use by-law did not provide adequate concentration limits for the parameters of interest, and was not used in this analysis.

Assumptions regarding treatment technologies for removal of various parameters outlined in Section 5.2.2 were also used for this analysis.

Results of this analysis are presented in Table 5.2.

5.2.5 DISCUSSION OF RESULTS

Table 5.2 presents results of various scenarios discussed previously. Total removal of all currently discharged (and monitored) contaminants would produce an estimated 105,605 tonnes of residual. This is not considered a likely scenario but provides an upper bound on the possible quantity which could be produ Assuming a 50% subject waste fraction, this would result in generation of 52,800 tonnes of subject waste per year.

The lower bound scenario assumes that existing storm sewer by-law limits would be imposed on total plant flows, and

results in an estimated 38,160 tonnes of residual. Again, assuming a 50% subject waste fraction, this results in an estimated 19,100 tonnes per year of subject waste.

The three scenarios related to BAT on process flow, and a 15:15 BOD:TSS requirement would produce residuals varying from 53,200-55,400 tonnes per year, depending on assumptions related to the percentage of process wastewater in total flows discharged by the smaller facilities. Results indicate relatively low sensitivity within the range of percentages considered, hence the lowest of the three numbers, ie. 53,200 tonnes per year was considered reasonable.

The estimate based on BAT requiring a 25:25 BOD:TSS effluent produces a lower total, at 39,370 tonnes per year, indicating that assumptions on likely effluent quality requirements have a significant impact on estimated residuals.

The estimate based on the USEPA Effluent Standards produces a total of 44,370 tonnes per year; however, the composition of this total is different to the others as removal of BOD or COD is not addressed.

Considering the different approaches used, and the fact that MISA requirements are not yet defined for the iron and steel sector, it is reasonable to assume that MISA might result in the production of an additional 40,000-55,000 tonnes of waste. The preliminary estimates indicate that 11,690-27,100 tonnes of this total might include clarifier sludge consisting of biological and miscellaneous settled solids. Considering the array of processes at an iron and steel facility this sludge might contain metals and organics which could classify it as a subject waste. It is probable that significant steps would be taken by steel companies to

implement stream separation to minimize contamination of large volumes of sludge with specific metals or organics which might classify them as subject waste. In the absence of data to confirm the quality of this sludge and based on the rationale that it is unreasonable to assume that none of this total would be subject waste, and it is also unreasonable to assume that 100% of this total is subject waste, it is considered reasonable at this time to assume that 50% of this total might be subject waste.

An estimated 27,700-28,300 tonnes of the estimated total would be ferric hydroxide sludge. If in a pure form, this sludge would not be considered subject waste, and in fact, could be recycled within the plant. However, contamination with zinc reportedly renders this waste unsuitable for recycling at this time. Considering the nature of iron and steel operations, it is possible that this sludge would also contain organics and metals, and might therefore be classified as leachate toxic. In the absence of any data, it has been assumed for the preliminary analysis that 50% of this total may be subject waste.

The estimated total also contains an estimated 0-11 tonnes of chromium hydroxide sludge, all of which would be subject waste.

The above calculations indicate quantities incremental to those reported in the 1986 IMIS database, and do not take into consideration changes implemented at any of the plants since that time. These estimates should be updated when the 1987 IMIS data becomes available, and when development of MISA for the iron and steel sector is further advanced.

5.3 METAL CASTING SECTOR DIRECT DISCHARGERS

5.3.1 ESTIMATES OF MISA IMPACT

The IMIS database provides information on two (2) direct dischargers in the metal casting sector. Further discussions with the MISA metal casting sector specialist indicated that these two companies (GM St. Catharines and Ford Windsor) were so much larger than the others in the sector, calculations based on these two companies would account for most of the impacts of MISA on the metal casting sector, of interest to this study.

Process flow rates for each facility were provided by the MISA sector specialist. Daily loadings from the IMIS database were divided by process flows to obtain process effluent concentrations which are compared to assumed BAT concentrations in Table 5.3. Incremental wastewater treatment residuals were calculated for four scenarios, namely:

i) All contaminants must be removed

ii) Total plant effluent must meet effluent concentration: 15 mg/L BOD or COD, 15 mg/L TSS, 15 mg/L oil and grease, 1 mg/L iron

iii) BAT applied to process streams must meet 15:15:15:1 effluent quality

iv) BAT applied to process streams must meet 25:25:15:1 effluent quality

It was assumed that phenols would be removed by chemical oxidation, producing no sludge, and that nitrogen compounds would be removed by steam or air stripping, producing no

sludge. It was assumed that flouride removal would be accomplished by activated alumina using either caustic or sulphuric acid as a regenerant (Patterson, 1985). The waste produced by this process was not included in preliminary calculations. Other technologies and assumptions are as for the iron and steel sector. Results of the above analyses are presented in Table 5.4.

5.3.2 DISCUSSION OF RESULTS

The IMIS database did not contain extensive data on metal concentrations in plant effluents, hence these could not be added to the preliminary estimates. However, it appears from the results on Table 5.3 that TSS removal is likely to generate the largest quantity of sludge. Considering the

Table 5.3
METAL CASTING DIRECT DISCHARGERS EFFLUENT DATA

Company	Total Flow (m^3/d)	Process Flow (m^3/d)	Contaminant	Loading (kg/d)	Effluent Concentration (process stream) (mg/l)	Assumed BAT Concentration Limit
General Motors (St. Catharines)	129,200	98,000	Phenols	14.3	0.14	0.02
			BOD_5	160	1.63	15 (25)
			NH_3-N	47.7	0.49	10
			Kjeldahl-N	43.7	0.45	10
			P	12.3	0.13	1
			TDS	3611	36.8	
			TSS	1526	15.6	15 (25)
			O & G	60	0.6	15
Ford (Windsor)	88,000	59,000	Phenols	19	0.32	0.02
			TSS	8400	108	15 (25)
			COD	2785	47.2	15 (25)
			Fe	156	2.6	1
			Fluoride	562	9.5	2*
			O & G	1047	17.8	15

*From existing storm sewer use by-laws.

Table 5.4
SUMMARY OF INCREMENTAL RESIDUAL CALCULATIONS FOR DIRECT DISCHARGERS
IN THE METAL CASTING SECTOR

Assumption	Assumed Effluent BOD/TSS (mg/l)	Residual Description and Quantity (tonnes/year)			
		Biological Solids	"TSS" Settled with Biological Solids	Total Clarifier Sludge	Oil & Grease Sludge
Total removal	0/0	1,350	14,700	16,050	1,000
Existing storm sewer use by-law on total flow	15/15	670	9,270	9,940	0
BAT on process streams	15/15	860	9,960	10,820	0
	25/25	600	8,930	9,530	0
Likely Range (tonnes/yr)		Included in clarifier sludge	Included in clarifier sludge	9,530-10,820	0
Likely Subject Waste (tonnes/yr)		Included in clarifier sludge	Included in clarifier sludge	4,800-5,400	0

(COPY/30W)

number of compounds in use at metal casting facilities, these sludges may contain a number of organics and metals, hence it is possible they will be classified as subject waste.

Total removal of parameters monitored in the IMIS database would generate an estimated 16,050 tonnes per year of clarifier sludge, and 1000 tonnes per year of oil and grease sludge. This scenario provides an upper bound on the incremental wastewater treatment residual quantities likely from the metal casting sector.

Assuming BAT on process flows only and an effluent requirement of 25:25 BOD:TSS provides the lowest of the estimates developed. The two hypothetical BAT scenarios provided estimates which ranged from 9530-10,820 tonnes per year of clarifier sludge. No oil and grease sludge was estimated in these scenarios. Because of the array of contaminants present at a metal casting facility, it has been assumed that 50% of the above total might be subject waste.

The USEPA Effluent limitations for the metal forming and casting sector provide BAT loadings based on plant production. Estimates based on the U.S. approach were not developed as part of this study because the level of detailed information on plant processes required to develop these loading limits was not available.

The estimates in Table 5.4 are based on 1986 data and do not take into account treatment processes onsite, or proposed treatment plant additions or modifications. Calculated quantities are incremental to 1986 loadings for this sector. Both facilities have been granted certificates of approval for additional onsite treatment since that time. The Ford Motor Company certificate is dated July 1987 and provides

for a polymer addition and sludge dewatering facility, rated at 2.18 tonnes/hour dry solids. Effluent from the system is required to meet a TSS concentration of 15 mg/l. General Motors in St. Catharines obtained a certificate of approval in January 1988 for a biological system to treat 130 m^3/d to an effluent concentration of 15 mg/l TSS, 20 ug/l phenol. The above estimates should be updated when the 1987 IMIS data is available, and also when MISA for the metal casting sector is further developed.

Chapter 6
EFFECT OF U.S. NATIONAL CATEGORICAL PRETREATMENT STANDARDS ON THE GENERATION OF HAZARDOUS SLUDGE

This chapter presents data on the quantities of hazardous sludge produced by metal finishers in some jurisdictions in the U.S. both before and after implementation of the U.S. National Categorical Pretreatment standards. The potential for waste reduction in this industry category is also discussed.

6.1 BACKGROUND

OBJECTIVE

The objective of the task discussed in this Chapter was to estimate quantities of hazardous sludge generated specifically as a result of compliance with the U.S. General Pretreatment Regulations. It was assumed at the outset that relevant sludge quantity data would be available through individual states under their hazardous waste manifest systems. The scope of the study was restricted to the State of Wisconsin, plus one or more other states for whom suitable data could be obtained.

U.S. GENERAL PRETREATMENT REGULATIONS

On June 26, 1978, the U.S. Environmental Protection Agency (EPA) promulgated General Pretreatment Regulations governing industrial discharges into publicly owned treatment works (POTW's). These regulations required many POTW's to develop local discharge standards for toxicants, plus pretreatment programs to monitor and enforce the standards. POTW pretreatment programs were subsequently developed and implemented in the early 1980's.

Concurrently with the development of local POTW pretreatment programs, EPA began to promulgate what are generally referred to as national categorical pretreatment standards. These standards specify concentrations of pollutants that may be discharged to a POTW by existing or new industrial users in specific industrial categories. Industrial discharges are required to meet the more stringent of local and national categorical standards.

U.S. EPA HAZARDOUS WASTE CLASSIFICATION SYSTEM

The U.S. Environmental Protection Agency has developed a classification system for hazardous wastes that is used to identify wastes shipped in the manifest system (40CFR 261). The classification system consists of the following major groups:

- Hazardous Wastes from Non-specific Sources (Codes F001 through F028)
- Hazardous Wastes from Specific Sources (Codes K001 through K136)
- Acute Hazardous Wastes (Codes P001 through P122)
- Toxic Wastes (Codes U001 through U249)

Classifications pertaining to wastewater treatment sludges are limited to the categories presented in Table 6.1.

F006 was determined to be the only significant category related directly to sludges generated by compliance with the national categorical pretreatment standards. The other categories are highly specific and apply to relatively few facilities.

Table 6.1
USEPA HAZARDOUS WASTE CLASSIFICATION SYSTEM

F006	-	Wastewater treatment sludges from electroplating operations
F019	-	Wastewater treatment sludges from chemical conversion of aluminum
F012	-	Quenching wastewater treatment sludges from metal heat treating operations
K002 to K007	-	Wastewater treatment sludge from the production of inorganic pigments
K106	-	Wastewater treatment sludge from the mercury cell process in chlorine production
K032	-	Wastewater treatment sludge from the production of chlordane
K035	-	Wastewater treatment sludges generated in the production of creosote
K037	-	Wastewater treatment sludges from the production of disulfoton
K040	-	Wastewater treatment sludge from the production of phorate
K041	-	Wastewater treatment sludge from the production of toxaphene
K044	-	Wastewater treatment sludges from the manufacturing and processing of explosives
K084	-	Wastewater treatment sludges generated during the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds

It should be noted that EPA has also designated three waste codes (F007, F008, and F009) for various types of spent plating bath solutions. These codes cover the spent liquid solutions, as well as residuals generated when the solutions are treated for metals recovery. It was determined that these waste codes did not reflect wastes generated from compliance with pretreatment regulations. It was also found that negligible quantities of these wastes were manifested in comparison to F006 waste.

6.2 ANALYSIS OF AVAILABLE DATA ON GENERATION OF HAZARDOUS WASTE F006 IN WISCONSIN

6.2.1 SELECTION OF INDUSTRY CATEGORIES FOR STUDY

For this study, it was determined that evaluation should be limited to the electroplating and metal finishing categories for the following reasons:

- This category contains nearly 70 percent of all industrial dischargers regulated by national categorical pretreatment standards in the U.S. (see Table 6.2).
- This category is one of the few that generates treatment sludge listed as hazardous.
- This category is the only one whose treatment sludge is separately categorized in the EPA hazardous waste manifest system.

Thus, this study focused on the generation of sludge classified as F006 under the EPA classification system.

Compliance with categorical pretreatment standards for the electroplating industry was required in the U.S. by June 30, 1984. Thus, the most significant increase in the generation of F006 waste would be expected starting in 1984.

6.2.2 DESCRIPTION OF F006 WASTE

The Code of Federal Regulations (40 CFR Part 261.31) defines F006 waste as wastewater treatment sludges from electroplating operations except from the following processes: (a) sulphuric acid anodizing of aluminum; (b) tin plating on carbon steel; (c) zinc plating (segregated basis) on carbon

Table 6.2

ESTIMATED NUMBER OF INDIRECT DISCHARGES IN THE U.S.
SUBJECT TO NATIONAL CATEGORICAL PRETREATMENT STANDARDS

Industry Category[a]	Estimated Number of Indirect Dischargers
Metal Finishing/Electroplating	10,561
Iron and Steel	162
Leather Tanning and Finishing	140
Aluminum Forming	72
Pulp and Paper Mills	261
Inorganic Chemicals (I)	21
Inorganic Chemicals (II)	10
Porcelain Enameling	88
Copper Forming	60
Organic Chemicals and Plastics	468
Textile Mills	1,406
Petroleum Refining	53
Metal Moulding and Casting	327
Coil Coating (I)	39
Coil Coating (II) (Canmaking)	81
Electrical and Electronic Components (II)	23
Battery Manufacturing	131
Nonferrous Metals (I)	85
Nonferrous Metals (II)	38
Coal Mining	0
Ore Mining	0
Steam Electric Power Plants	85
Pesticides	38
Timber Products	46
Pharmaceuticals	277
Plastics Forming	1,066
Nonferrous Metals Forming	107
TOTAL ESTIMATE	15,645

[a] Source: EPA Effluent Guidelines Division.

[b] Metal Finishing and Electroplating facilities are combined as one category in this table; therefore, the number of industry categories shown totals only 24.

steel; (e) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel; and (f) chemical etching and milling of aluminum. Figure 3-1 is a general schematic diagram of a typical electroplating wastewater system, indicating where F006 waste is generated. EPA estimates that 4,500 facilities in the U.S. are generating F006 waste out of the total of 10,561 indirect electroplating metal finishing dischargers.

Summaries of waste characterization data for F006 wastes are contained in Table 6.3. The concentration of individual metals is dependent on the type of electroplating solutions used in the electroplating process and the moisture content of the sludge.

Generators of F006 fall under U.S. Standard Industrial Classification (SIC) Major Group 34, entitled Fabricated Metal Products, Except Machinery and Transportation Equipment. Metal finishing activities are also carried out by facilities in a number of other SIC groups.

6.2.3 MANIFESTED SHIPMENTS OF F006 IN WISCONSIN

Data on F006 waste shipments in Wisconsin was obtained from the Wisconsin Department of Natural Resources (DNR) computerized Manifest System for tne years 1981 through 1988. It was discovered that the data was incomplete, necessitating further efforts to access additional manifest data maintained in other DNR files. It was also found necessary to contact the industries individually to clarify the data. Because of the effort involved, data acquisition was limited to industries served by the Milwaukee Metropolitan Sewerage District.

Table 6.3
COMPOSITION OF UNTREATED F006 WASTE[a]

Constituent	Concentration[b]
General	
Solids[c]	2-73%
Water	24-98%
Cyanide	0-0.05%
Total organic Carbon	0.04-3.0%
Metals	
Antimony	<10-22.4
Arsenic	<0.4-6.24
Barium	0.74-85.5
Beryllium	<0.1-97.6
Cadmium	0.003-4,070
Total Chromium	<0.002-290,000
Copper	1.4-28,100
Lead	<0.001-24,500
Mercury	<0.2-<1
Nickel	0.06-170,000
Selenium	<0.03-<23
Silver	<0.6-38.9
Thallium	<10-20
Vanadium	1.26
Zinc	8.86-90,200
Cyanide Total	<0.025-1,970
Cyanide Amenable	0.003-162
Hexavalent Chromium	<0.001-910
Organics (ppb)	
Acetone	<130
Acrolein	-
Acrylonitrile	-
Benzene	-
Bromodichlormethane	<4.9-<5.2
Bromoform	<4.9-<5.2
Bromomethane	<13
2-Butanone	<26
Carbon disulfide	<4.9-<5.2
Carbon tetrachloride	<4.9-<5.2
Chlorobenzene	<4.9-<5.2
Chloroethane	<13
2-Chloroethyl vinyl ether	<4.9-<5.2
Chloroform	<4.9-<5.2
Cis-1,3-dichloropropene	<13
1,1-Dibromochloromethane	<4.9-<5.2
1,2-Dichlorethane	<4.9-<5.2

Table 6.3
(continued)

Constituent	Concentration[b]
Organics (continued)	
1,1-Dichlorethylene	<4.9-<5.2
1,2-Dichloropropane	<4.9-<5.2
Ethylbenzene	<4.9-<5.2
2-Hexanone	<25-<26
Methylene chloride	<12-<13
4-Methyl-2-pentanone	<25-<26
Styrene	<4.9-<5.2
1,1,2,2-Tetrachlorethane	<12-<13
Tetrachlorethylene	<4.9-<5.2
Toluene	<4.9-<5.2
Trans-1,2-dichloroethylene	<4.9-<5.2
Trans-1,3-dichloropropene	<4.9-<5.2
Trichloroethylene	<4.9-<5.2
Vinyl acetate	-
Vinyl chloride	<12-<13
Xylenes (total)	<4.9-<5.2
Other Parameters	
Fluoride	268
Oil and grease (mg/g)	0.03-37.7
Moisture %	29.1-91.2
SP gravity (g/mL)	1.38-1.493
Acidity as $CaCO_3$ (mg/L)	1,412
Alkalinity as $CaCO_3$ (mg/L)	-
Sulfide	21
Total organic Carbon	<5,800

[a] Source: EPA

[b] Concentrations in ppm, except as noted

[c] Solids consist of metal precipitate (usually hydroxides) and unreacted treatment chemicals (generally lime))

Table 6.4 shows the manifested shipments of F006 waste for the Milwaukee generators for 1981-1988. Because of the regulatory exemption for small generators, only 6 generators are listed. The Milwaukee sewerage district actually contains about 90 facilities which are covered by federal electroplating and/or metal finishing categorical pretreatment standards of which about 60 facilities are generating F006 waste. Thus, only 10 percent of the facilities generating F006 waste in Milwaukee are large enough to be required to report sludge quantities under the manifest system.

Prior to 1985, reporting was required for generators of more than 1000 kilograms/month; starting in 1985, reporting was required for generators of more than 100 kilograms/month. However, even the reduced limit triggering reporting did not result in any new generators added to the manifest list from Milwaukee. Because of their relatively large size, the six reporting facilities are believed to generate most of the total quantity of F006 waste in the District.

An explanation of the data and trends exhibited in Table 6.4 is presented below.

6.2.4 TRENDS IN SHIPMENTS OF F006 WASTE PRIOR TO 1984

Prior to 1984, pretreatment was not required in Milwaukee, except for cadmium. F006 waste generated prior to 1984 was the result of a few facilities installing pretreatment facilities on their own. For example, Allen Bradley Co. installed a pretreatment facility on its own in 1981, 2 to 3 years ahead of the time it was required. Master Lock Co. installed a pretreatment facility in 1980 as a result of the cadmium limitation imposed by the Milwaukee sewerage district; the pretreatment facility also removed other heavy metals. Eaton Corporation also installed pretreatment facilities prior to the regulatory implementation deadline.

Table 6.4
MANIFESTED SHIPMENTS OF F006 WASTE BY MILWAUKEE, WISCONSIN, COMPANIES
(pounds)

Generator	1981	1982	1983	1984	1985	1986	1987	1988[a]
Allen Bradley Co. Inc.	342,000	458,000	195,813	341,724	0	0	37,659	47,272
Briggs & Stratton	0	0	0	329,510	615,900	579,249	408,120	499,800
Eaton Corp.	0	44,203	8,213	2,802	3,736	3,674	6,461	4,742
Master Lock Company Inc.	231,000	346,500	390,500	253,550	348,820	203,964	267,120	314,160
OMC-Evinrude	0	0	0	35,000	60,000	45,700	84,000	67,200
Snap-On Tools	0	30,900	59,391	473,129	407,637	343,339	347,774	80,660
TOTAL GENERATED	573,000	879,603	653,917	1,435,715	1,436,093	1,175,926	1,171,134	1,013,834

[a]Data through June 1988

Source: Wisconsin Department of Natural Resources

It should be pointed out that those facilities that installed pretreatment facilities prior to the regulatory deadline in Milwaukee did so primarily in anticipation of the impending regulatory requirement. Therefore, much of the F006 waste generated prior to 1984 can actually be attributed to the national categorical standards.

INCREASE IN F006 WASTE IN 1984

The significant rise in F006 waste quantities in 1984 was a direct result of the start-up of the pretreatment facilities mandated by the national categorical pretreatment standards for the electroplating/metal finishing industry. As noted previously, compliance dates for these standards started in 1984.

DECLINING TREND OF F006 SHIPMENTS AFTER 1984

The data show that shipments of F006 wastes from the Milwaukee industries have been on a declining trend since 1984, although the data for 1988-to-date suggests that a significant increase will occur in 1988. Discussions with company representatives indicate that each company is continually attempting to reduce its quantity of F006 shipments through a variety of techniques. The companies report considerable success in these efforts, although the data does not show significant declines since 1984. A notable exception is Allen Bradley Co., which shows markedly reduced F006 shipments after 1984. Apparently, this is a result of reclaiming metals from the sludge and eliminating its categorization as F006 waste.

CORRELATION OF SLUDGE QUANTITIES WITH INDUSTRY SIZE CHARACTERISTICS

Each of the facilities listed in Table 6.4 is classified as an "integrated" facility by EPA, meaning that electroplating and metal finishing operations are not the principal business and are only one of several processes performed in the facilities. Therefore, relating sludge production to facility size characteristics such as number of employees or even overall production volume would not be meaningful as a way to project sludge quantities generated at other facilities.

6.2.5 OTHER SOURCES OF DATA ON F006 WASTE

An attempt was made to obtain additional data on F006 waste from other states, with very limited success. A summary of attempts made in this regard is presented below.

MICHIGAN

Contact with the Michigan Department of Natural Resources indicated that manifest data for F006 waste prior to 1985 is incomplete. Subsequent data is also questionable, and has caused staff to begin manual editing of data starting in 1988. Because of these problems, data acquisition from this source was not pursued.

NEW YORK

Contact with the New York Environmental Conservation Department revealed that New York does not categorize hazardous waste according to the U.S. EPA system. Only 3 waste categories are employed, hence data from this source was not useful for the purposes of this study.

MINNESOTA

The Minnesota Waste Management Board was found to maintain a computerized manifest system similar to Wisconsin's. However, no data was available prior to 1985 to enable comparison of sludge quantities before and after compliance with categorical pretreatment standards. Reported quantities of F006 waste shipments in Minnesota for 1985, 1986, and 1987 are shown in Table 6.5.

Table 6.5
F006 WASTE SHIPMENTS IN MINNESOTA 1985, 1986 AND 1987

Test	Pounds of F006 Manifested	Tonnes of F006 Manifested
1985	4,014,000	1825
1986	3,508,000	1595
1987	3,326,000	1512

The data indicates a decreasing trend in the total quantity manifested, similar to that shown in Wisconsin.

NATIONAL ASSOCIATION OF METAL FINISHERS

The National Association of Metal Finishers does not maintain any data on sludge quantities produced by its member companies. Discussions with a technical advisor for the NAMF confirmed that there is much emphasis in the industry on reducing the quantity of sludge solids through process modifications and reducing the water content of the sludge through dewatering and drying.

AMERICAN ELECTROPLATER'S SOCIETY

The American Electroplater's Society also does not maintain any data on sludge quantities produced by electroplaters in

pretreatment operations. The technical advisor for the society indicated that manifest data from the states was the best source of information.

U.S. EPA

EPA is the repository of biannual hazardous waste manifest reports submitted by each state. The reports contain data on quantities of hazardous waste manifested by waste category. However, development and enforcement of manifesting procedures has evolved over time and has not been consistent from state to state. Therefore, the data is probably not reliable, particularly for years prior to 1985.

HAZARDOUS WASTE HANDLING FACILITIES

Several hazardous waste handling facilities were contacted but none would reveal data on quantities of wastes handled.

U.S. CONGRESSIONAL BUDGET OFFICE DATA

In 1985, the U.S. Congressional Budget Office (CBO) published the results of an extensive study of hazardous waste generation and disposal practices. Table 6.6 shows the CBO estimates of historical and forecasted quantities of various types of hazardous wastes for the United States.

The CBO waste category termed "metal-containing sludge" corresponds roughly to EPA F006 waste. Assuming waste reduction efforts by industry, this category was forecasted to decrease in quantity during the period 1983 to 1990. Because the compliance dates for the electroplating and metal finishing pretreatment standards occurred in 1984, a significant increase in metal-containing sludge would have been expected starting in 1984. The specific role of the federal

Table 6.6

ESTIMATED CHANGES IN WASTE GENERATION PATTERNS 1983 AND 1990
(In thousands of metric tons)

Waste Type	Quantity in 1983	1990 Quantity With No Waste Reduction	1990 Quantity With Waste Reduction	Percent Change in 1990 Due to Waste Reduction
Nonmetallic Inorganic Liquids	82,261	89,908	71,705	-12.8
Nonmetallic Inorganic Sludge	28,061	28,177	26,768	-4.6
Nonmetallic Inorganic Dusts	21,120	22,214	19,993	-5.3
Metal-Containing Liquids	19,760	19,983	5,995	-69.7
Miscellaneous Wastes	15,415	16,759	15,921	+3.3
Metal-Containing Sludge	14,497	15,147	13,632	-6.0
Waste Oils	14,249	13,932	11,842	-16.9
Nonhalogenated Solvents	12,130	11,869	10,682	-11.9
Halogenated Organic Solids	9,784	11,558	11,558	+18.1
Metallic Dusts and Shavings	7,733	8,112	6,895	-10.8
Cyanide and Metal Liquids	7,383	7,284	1,821	-75.3
Contaminated Clay, Soil, Sand	5,461	5,748	5,748	+5.3
Nonhalogenated Organic Solids	4,578	5,227	5,227	+14.2
Dye and Paint Sludge	4,236	4,112	3,086	-27.1
Resins, Latex, and Monomer	4,018	4,586	4,357	+8.4
Oily Sludge	3,734	3,556	3,200	-14.3
Halogenated Solvents	3,479	3,803	3,423	-1.6
Other Organic Liquids	3,435	3,755	2,817	-18.0
Nonhalogenated Organic Sludge	2,242	2,478	2,478	+10.5
Explosives	720	821	780	+8.3
Halogenated Organic Sludge	715	683	683	-4.5
Cyanide and Metal Sludge	557	593	505	-9.3
Pesticides, Herbicides	26	28	24	-7.7
Polychlorinated Biphenols	1	1	1	0.0
Total	265,595	280,364	229,141	

Source: U.S. Congressional Budget Office. "Hazardous Waste Management: Recent Changes and Policy Alternatives" 1985 (Table 12)

categorical pretreatment standards in increasing sludge quantities is not mentioned in the CBO report, so it is not known whether this role was actually addressed.

6.3 WASTE REDUCTION PRACTICES

The Wisconsin and Minnesota data, the CBO data, and discussions with industry representatives all indicate a declining trend in F006 waste as a result of waste reduction practices by industry. This trend may be accelerated by a ban on landfill disposal of untreated F006 waste, scheduled to take effect August 8, 1988. The ban requires that F006 waste be treated and pass the toxicity characteristic leachate procedure (TCLP) test for metals before it can be landfilled. The ban will have the effect of increasing sludge disposal costs, providing additional incentive for waste reduction and for on-site detoxification to render the sludge non-hazardous.

In a recent publication entitled "Best Demonstrated Available Technology (BDAT) Background Document for F006," the EPA described several technologies being implemented by facilities to treat F006, which may allow it to be delisted as a hazardous waste. These include:

- Chemical stabilization, using agents such as cement, lime, or kiln dust to minimize the quantities of metals that leach when the waste is in contact with water

- Vitrification, using chemical agents to produce a glass-like mass that limits leachability of metals

- High temperature metal recovery using volatilization and collection processes to recover metals from wastes

- Phosphate precipitation, a patented process to produce a stable sludge

- Crystallization, a process in which metal carbonates are crystallized on an inert material for reuse in the electroplating process

6.4 LITERATURE REVIEW

Numerous contacts made with federal and state agencies, industry associations, industry technical consultants, and individual companies did not reveal the existence of any studies directly addressing the role of industrial pretreatment regulations on the production of sludge. A list of references obtained during this study is provided in Appendix 'A'; several of these references also contain bibliographies.

Chapter 7
STUDY RESULTS

7.1 LIMITATIONS OF DATA

The results of the study are summarized in Table 7.1 and are discussed in detail throughout the text. Table 7.1 indicates that the impact of MISA on the sectors chosen is likely to include generation of 60,300-80,800 tonnes of wastes, an estimated 31,600-43,200 tonnes of which may be subject waste. The calculations were based on a number of assumptions and also on data which have a number of limitations. The major limitations on the estimates are as follows:

i) Calculations are based on the assumption that MISA effluent limitations will be similar to USEPA effluent limitations for similar industries. The accuracy of this assumption can not be established until MISA is further developed.

ii) Calculations for direct dischargers are based on 1986 MOE IMIS data and will not take into account reductions in loading resulting from installation of treatment systems installed since December 1986. The metal casting sector estimates in particular may be lower if based on more recent data, as major treatment systems have been installed in 1987 and 1988. The estimates should be revised when 1987 IMIS data is available.

iii) Calculations for the metal finishing sector are based on a number of assumptions (outlined in Chapter 3) applied to data collected in a 1984 survey. These

Table 7.1
SUMMARY OF MISA TOTAL RESIDUAL ESTIMATES

Source	"Likely" Total Waste Quantity Range (tonnes/year)	Waste Description	Low Total Estimate (tonnes/year)	High Total Estimate (tonnes/year)	"Likely" Subject Waste Quantity (tonnes/year)
Metal Finishing	7-20	Metal hydroxide sludge	7	20	7-20
Directs	900-2,200	Metal hydroxide sludge	900	2,200	900-2,200
Indirects (250 d/year)					
Iron & Steel					
Directs	0-11	Metal hydroxide sludge	0	630	0-11
(365 d/year)	27,700-28,300	Ferric hydroxide sludge	25,900	31,800	13,000-14,000
	11,700-27,100	Clarifier sludge	11,700	61,800	5,800-13,500
	0	Oil and grease sludge	0	11,400	0
Metal Casting					
Directs	9,500-10,800	Clarifier sludge	9,500	16,000	4,800-5,400
(365 d/year)	0	Oil and grease sludge	0	1,000	0
Organic Chemicals					
Directs	560	Metal hydroxide sludge	540	560	560
(250 d/year)	6,000-7,400	Clarifier sludge	1,700	12,500	3,000-3,700
Indirects (250 d/year)	250	Metal hydroxide sludge	250	250	250
Inorganic Chemicals					
Directs (250 d/year)	1,400-1,480	Clarifier sludge	470	2,040	700-740
Indirects (250 d/year)	1,300-2,700	Metal hydroxide sludge	1,300	2,700	1,300-2,700
Total	59,300-80,800		52,300	142,900	30,300-43,100

estimates are approximate only, but because the quantity of waste material involved is low compared to other estimates, the error associated with these assumptions is not likely significant.

iv) Calculations for the chemical sector indirect dischargers are associated with removal of USEPA regulated parameters only, and are likely an underestimate of the impacts of MISA.

7.2 SUMMARY OF RESULTS

MAIN FINDINGS

The main findings of this study are as follows:

1. Direct dischargers in the iron and steel sector are the industry group considered in this study on which MISA is estimated to have the most significant impact. It is estimated that 0-11 tonnes of metal hydroxide sludge, 27,700-28,300 tonnes of ferric hydroxide solids, and 11,700-27,100 tonnes of clarifier sludge would be produced as a result of MISA implementation. These wastes may be contaminated with oil, grease, miscellaneous metals and organics, hence it has been assumed for preliminary planning purposes only that 50% of the above totals could be subject waste.

2. MISA impact on direct dischargers in the metal finishing sector is expected to be minimal, producing an estimated additional 7-20 tonnes per year of metal hydroxide sludge, all of which would be subject waste.

3. MISA impact on indirect dischargers in the metal finishing sector is estimated to produce an incremental 900-2,000 tonnes per year of metal hydroxide sludge, all of which would be considered subject waste.

4. Based on 1986 IMIS data, MISA impact on direct dischargers in the metal casting sector is estimated to generate an additional 9,500-10,800 tonnes per year of clarifier sludge, of which 50% could be subject waste. These estimates do not take into account potential reductions in loading resulting from treatment plants installed at two major facilities in 1987, and are therefore likely to be significant overestimates.

5. MISA impact on the organic chemical direct dischargers is estimated to generate 560 tonnes of metal hydroxide sludge, all of which would be subject waste, and 6,000-7,400 tonnes of clarifier sludge, and estimated 50% of which may be subject waste.

6. MISA impact on inorganic chemical direct dischargers is estimated at 1,400-1,480 tonnes of additional clarifier sludge, 50% of which may be subject waste.

7. Based on removal of regulated pollutants only, MISA is estimated to generate an additional 1,550-2,950 tonnes of metal hydroxide sludge, all of which would be subject waste from indirect dischargers in the chemical sector. Most treatment requirements in this sector are expected to be met by process changes and granular activated carbon treatment rather than by end of pipe treatment. The above estimate does not take additional residuals produced by removal of conventional parameters (e.g. TSS, etc.) in wastewater treatment systems into account, and are therefore considered underestimates.

8. A review of available data on the impacts of U.S. pre-treatment programs on hazardous waste generation by the electroplating/metal finishing sector suggests an initial increase in sludge generation as companies comply with treatment requirements, followed by a decline in sludge generation as the economics of sludge disposal encourage increased 4R's and onsite treatment.

7.3 CONCLUSIONS

1. Of the sectors considered, the iron and steel sector is the one on which MISA implementation is likely to have the greatest impact.

2. The impacts of MISA on indirect dischargers is difficult to estimate because of the limited data available.

7.4 RECOMMENDATIONS

1. The estimates contained in this report are approximate only, based on the data available at this time, but involved significant subjective professional judgement. These should be updated as MISA becomes more defined, because the actual format of MISA was somewhat nebulous at the time of writing.

2. The above estimates should be updated when the 1987 IMIS data becomes available, as calculations based on 1986 data are likely overestimates, particularly for the metal casting sector.

APPENDIX A

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APPENDIX A
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APPENDIX B

DETAILED CALCULATIONS OF INCREMENTAL WASTEWATER TREATMENT RESIDUAL PRODUCTION BY INDIRECT DISCHARGING METAL FINISHERS IN ONTARIO AS A RESULT OF MISA IMPLEMENTATION

Appendix B

DETAILED CALCULATIONS OF INCREMENTAL WASTEWATER TREATMENT RESIDUAL PRODUCTION BY INDIRECT DISCHARGING METAL FINISHERS

B.1 METHOD A.1--BASED ON WATER QUALITY DATA FROM THE 1983/84 SURVEY OF METAL FINISHERS, AND USING NaOH for pH ADJUSTMENT

B.1.1 DATA GIVEN

From the Hanna report (1984):

- No. of companies that reported discharge destination = 251
- No. of companies that reported discharged to sanitary sewer = 211
- Assume on the basis of above figures that 84% of metal finishers are indirect dischargers

Water quality was obtained for 116 of the 296 companies that responded to the 1983/84 survey:

- No. of companies that reported effluent flow rate = 78
- Average flow rate = 79,000 m^3/yr (17,600 x 10^3 Igal/yr)
- No. of companies that reported metal concentrations in their effluent (indirects) = 87
- No. of companies that reported both metal concentrations and flow rate = 62

- Table B.1 gives the Pretreatment Standards for Existing Sources (PSES) for indirect metal finisher dischargers as given in the USEPA Federal Register (1980). It is assumed that this is the standard that will be used for MISA implementation on indirect dischargers in Ontario.

- Table B.2 gives the mass of dry solids produced per unit mass of metal precipitated using NaOH for pH adjustment.

B.1.2 ASSUMPTIONS

Various assumptions on which the calculations were based are outlined in Table B.3.

B.1.3 CALCULATION

The mass of incremental sludge produced by each company in the Environment Canada database was based on the amount of metal that must be removed from each effluent to achieve the PSES standard. The total incremental mass of sludge produced by the 87 respondents was then given by the sum of the incremental amounts produced by each company.

Table B.4 provides sample calculations for some of the 87 companies that provided data on metal concentrations. Each heading in the table is described below.

Table B.1
PSES STANDARDS
(mg/l)

Metal	Max. Monthly Av. Concentration (mg/l)
Cr	1.71
Cd	0.26
Cu	2.07
Ni	2.38
Pb	0.43
Zn	1.48

Source: USEPA, Federal Register, (1980)

Table B.2
SOLIDS GENERATION IN
PRECIPITATION REACTION
(NaOH)

	kg dry solids generated per kg metal precipitated
Cr	1.98
Cd	1.3
Cu	1.53
Ni	1.58
Pb	1.5
Zn	1.52

Source: USEPA, 625/5-79-016, (1979)

Table B.3

ASSUMPTIONS ON WHICH WATER QUALITY BASED ESTIMATES DEVELOPED

Assumption	Basis for Assumption/Reference
1. There are approximately 800 metal finishers in Ontario.	D. Edwards, CAMF
2. The number of metal finishers in Ontario has not changed significantly since 1983.	D. Edwards, CAMF J. Portugais, EC B. Forrestal, ORF
3. 84 percent of metal finishers in Ontario are indirect dischargers.	84 percent of the respondents (211/251) in the 1983/84 survey were indirect dischargers. Used due to the absence of more recent data.
4. NaOH will be used for pH adjustment by the companies that will install conventional treatment systems to meet MISA requirements.	Few metal finishers now use lime for pH adjustment due to the greater sludge volume produced and the resulting high cost of sludge disposal (Durney, 1984).
5. The volume of incremental sludge produced by the metal finishers that did not provide water quality data is proportional to the volume produced by the 87 respondents that did.	It is assumed that the 87 respondents are representative of the metal finishers in Ontario in the absence of more recent or more comprehensive data.
6. Changes in metal concentrations in the effluent of individual plants since 1983 do not have a significant impact on the total volume of incremental sludge produced as a result of the new standard.	The 1983 water quality data is the most recent source of information and is used in the absence of better data.
7. Metal finishers will reduce the concentration of metals in their effluent as a direct result of MISA implementation. Thus, incremental sludge produced is assumed to be a direct result of MISA implementation.	See main text for comments.
8. The treatment system that is assumed to be used to meet the new standard will consist of conventional hydroxide precipitation, with settling and sludge dewatering.	With the possible exception of cadmium and lead, this treatment should be sufficient to meet the PSES standards. See main text for comments.
9. The dewatered sludge is 20-40 percent solids by weight.	Range given in USEPA (1982) is 20 to 40 percent using sludge dewatering equipment.
10. Incremental sludge produced by reducing metal concentrations from levels achievable (by conventional ion exchange polishing of the effluent for example) is insignificant compared to the sludge produced by conventional treatment.	For companies with conventional treatment and tertiary end-of-pipe treatment, the mass of metals removed by conventional treatment is much greater than the amount removed by end-of-pipe tertiary treatment. In addition, instream treatment with technologies such as evaporative recovery does not produce sludge. See text for further comments.

Table B.4
INCREMENTAL SLUDGE PRODUCTION
BY METAL FINISHERS
INDIRECT DISCHARGERS

Flow (1000 Igal/yr)	Metal	Metal Code	Concentration (mg/l)	PSES Standard (mg/l)	Exceedance (mg/l)	Incremental Mass Metal Precipitated (kg/yr)	Incremental Mass of Dry Solids (kg/yr)	
17600	Cr	3	1.0	1.71	0	0	0	one company
17600	Ni	6	5.4	2.38	3.02	241	380	one company
17600	Zn	8	2.7	1.48	1.22	97	148	one company
33000	Cr	3	1.4	1.71	0	0	0	
33000	Cu	5	1.2	2.07	0	0	0	
33000	Ni	6	2.3	2.38	0	0	0	
33000	Zn	8	1.8	1.48	0.32	48	73	

Metal	Code
Cr	3
Cd	4
Cu	5
Ni	6
Pb	7
Zn	8

Flow Rate

If the flow was not indicated by a company, then it is assumed that the plant has a flow rate equal to the average flow.

The flow rate is repeated for each metal to simplify the spreadsheet calculations. For example, the total flow for the first company listed in Table B.4 is 17,600,000 Igal/yr.

Note that some companies have more than one indirect discharge.

Exceedance

The exceedance is the amount of metal that must be removed to meet the PSES standard.

Exceedance = metal concentration - PSES standard for the metal

Incremental Mass of Metal Precipitated

This is the amount of metal that must be removed to meet the PSES standard. It is given by:

Exceedance x flow rate

Incremental Mass of Dry Solids

This is the mass of dry solids that will produced as a result of meeting the PSES standard. It is given by:

$$\text{Incremental mass of metal precip.} \times \frac{\text{kg dry solids generated*}}{\text{kg metal precip.}}$$

* - from Table B.2.

Sample Calculation

First company listed in Table B.4.

Q = 17,600 x 10^3 Igal/yr
Nickel concentration = 5.4 mg/l
PSES standard = 2.38 mg/l for nickel

Therefore:

Exceedance = 5.4 - 2.38
= 3.02 mg/l

Incremental mass of metal precipitated =

17,600 x 10^3 Igal/yr x 4.53 L/gal x 3.02 mg/l x kg/10^6 mg = 241 kg/yr

Therefore:

Incremental mass of dry solids produced by this company as a result of meeting the PSES standard for nickel =

$$241 \text{ kg/yr} \times \frac{1.58 \text{ kg* solids}}{\text{kg Ni precip.}} = 380 \text{ kg/yr}$$

* Ref. EPA 625/5-79-016

B.1.4 RESULTS

1. From Table B.4:
Total incremental mass of dry solids produced by the 87 respondents as a result of the new standard = 56,309 kg/yr.

2. No. of indirect dischargers:
84% x 800 companies = 673 companies

3. Incremental residual produced by all indirect metal finishers (dry basis):

   56,309 x 673/87 x tonnes/1000 kg = 435 tonnes/yr (dry basis)

4. Incremental residuals produced by all indirect metal finishers discharging indirect (wet basis) varies from 435 t/yr/0.2 = 2175 t/yr (wet basis at 20% solids) to 435 t/yr/0.4 = 1087 t/yr (wet basis at 40% solids).

B.2 METHOD A2--USING LIME FOR pH ADJUSTMENT

Hydrated lime may also be used for pH adjustment. Although lime is less expensive than liquid caustic, it results in greater volumes of sludge produced.

B.2.1 CALCULATION

The mass of metal precipitated is calculated using the same methodology that is employed when assuming that caustic (NaOH) is used for pH adjustment. The mass of dry solids produced per unit mass of metal precipitated is greater for lime treatment. The precipitation factors for lime treatment are given in Table B.5.

In addition, alkalinity in the process waste stream consume lime and adds to the solids generation. This is taken into account using the lime consumption factors and the lime solids production factor given in Table B.6.

Table B.5
PRECIPITATION FACTORS FOR LIME TREATMENT

	kg dry solids generated per kg metal precipitated
Cr	2.24
Cd	1.52
Cu	1.75
Ni	1.8
Pb	1.5
Zn	1.74

Source: USEPA, 625/8-81-007 (1981)

Table B.6
LIME CALCULATION FACTORS

	Lime Consumption Factor
Cr	2.6 kg $Ca(OH)_2$/kg Cr
Other Metals	2.2 kg $Ca(OH)_2$/kg metal

Lime Solids Production Factor
0.1 kg dry solids/kg hydrated lime consumed

Source: USEPA, 625/8-81-007 (1981)

Sample Calculation

First company listed in Table B.4, from previous calculation, incremental mass of metal precipitated = 241 kg/yr.

Therefore, the incremental mass of dry solids produced =

$$\left(241 \text{ kg Ni/yr} \times \frac{1.8 \text{ kg* dry solids}}{\text{kg Ni precip.}}\right) +$$

$$\left(241 \text{ kg Ni/yr} \times \frac{2.2 \text{ kg lime}}{\text{kg Ni}} \times \frac{0.1 \text{ kg dry solids}}{\text{kg lime consumed}}\right) = 486 \text{ kg/yr}$$

* Ref. EPA 625/8-81-007

This compares to 380 kg/yr produced assuming NaOH for pH adjustment, and does not account for potential precipitation of counterions (e.g. $CaSO_4$ in a sulfuric acid solution). It is therefore a conservatively low estimate.

B.2.2 RESULTS

1. Based on above calculation, applied to 87 companies, total incremental mass of dry solids produced by the 87 respondents as a result of PSES = 72,271 kg/yr

2. No. of indirect dischargers:
   84% x 800 companies = 673 companies

3. Incremental sludge produced by all indirect metal finishers (dry basis):

   72,271 x 673/87 x tonne/1000 kg = 560 tonne/yr (dry basis)

4. Incremental sludge produced by all indirect metal finishers (wet basis) varies from 560 t/yr/0.2 = 2800 t/yr (wet basis at 20% solids) to 560 t/yr/0.4 = 1400 t/yr (wet basis at 40% solids).

B.3 METHOD B--BASED ON SLUDGE PRODUCTION DATA FROM THE 1983/84 SURVEY OF METAL FINISHERS

B.3.1 DATA GIVEN

From the Hanna report (1984):

- No. of companies that responded to the survey = 296
- No. of companies that reported discharge destination = 251
- No. of companies that reported discharged to sanitary sewer = 211
- No. of companies that reported having neutralization systems = 160 .
- No. of companies that reported having settling systems = 97
- No. of companies that reported having sludge dewatering systems = 25
- No. of companies that reported quantity of sludge produced = 124
- Total volume of process sludge produced by the 124 respondents = 10,618 m^3/yr

B.3.2 ASSUMPTIONS

Various assumptions on which the calculations were based are outlined in Table B.7.

Table B.7
ASSUMPTIONS ON WHICH SLUDGE QUANTITY BASED ESTIMATES DEVELOPED

Assumption	Basis for Assumption/Reference
1. All of the companies that reported on the quantity of sludge produced had neutralization treatment, at a minimum.	The sludge production data given in the Hanna report was for "Hazardous Wastes Process Sludge".
2. Metal finishers will install treatment systems that will consist of neutralization, settling, and sludge dewatering as a direct result of the anticipated MISA requirement for pretreatment, assumed at this time to be conventional treatment.	See main text for other reasons why a company may install treatment facilities. With the possible exception of cadmium and lead, this type of treatment should be sufficient to meet PSES standards. See main text for comments.
3. The average sludge production by the 124 companies that gave information on sludge quantities is representative of the companies not covered by the survey.	Assumption made in the absence of more detailed data.
4. Settling is assumed to reduce sludge volume by 70 percent over neutralization alone.	USEPA (1982).
5. Sludge dewatering is assumed to reduce sludge volume by 95 percent over neutralization alone.	USEPA (1982).
6. Companies without treatment in 1983 will not have installed treatment systems prior to MISA implementation.	Assumption made as a basis for making a conservative estimate of incremental sludge production. Method B2 assumes that some of the companies have installed treatment systems.
7. Dewatered sludge is assumed to be 20-40 percent solids by weight.	Range given in the literature (USEPA, 1982; Sitting, 1978) is 20-40 percent solids.

B.3.3 METHOD B1 CALCULATION

The average sludge production (per company) for metal finishers with sludge dewatering is calculated based on data from the 1983/84 survey. The number of indirect dischargers that will install treatment systems as a result of MISA implementation is also determined.

The incremental sludge volume produced is then calculated by multiplying the average sludge production per company by the number of companies which will install treatment systems.

This volume of sludge is then converted to mass of sludge on a dry basis and a wet basis.

The available data had to be manipulated to calculate how much sludge was associated with each type of treatment system, as 160 companies reported treatment system descriptions, but only 124 companies reported sludge quantities. This manipulation is presented below:

1. Distribution of treatment systems

From the 160 companies that reported treatment:

No. of companies with neutralization only = 160 - 97
= 63

Percent with neutralization only = 63/160
= 39%

No. of companies with neutralization and settling only
= 97 - 25
= 72

Percent with neutralization, settling and sludge dewatering = 72/160
= 45%

No. of companies with neutralization, settling and sludge dewatering = 25

Percent with neutralization, settling and dewatering
= 25/160
= 16%

2. Distribution of treatment systems corresponding to the 124 companies that reported sludge production quantities:

No. of companies with neutralization only = 0.39 x 124
= 48 companies

No. of companies with neutralization and settling only
= 0.45 x 124
= 56 companies

No. of companies with neutralization, settling and sludge dewatering = 0.16 x 124
= 20 companies

Total =124 companies

3. Average volume of sludge as a function of treatment:

Let V be the average volume of sludge produced by companies having neutralization only (m^3/company per yr).

Then,

Avg. volume of sludge produced by companies with neutralization and settling = 0.3 V
(70% reduction)

Avg. volume of sludge produced by companies with neutralization, settling and dewatering = 0.05 V
(95% reduction)

The various assumptions outlined in earlier sections are used to develop a typical quantity of sludge produced by companies with dewatering systems, which

$$48\ V + (56 \times 0.3\ v) + (20 \times 0.05\ V) = 10{,}618\ m^3/yr$$

Therefore,

$$V = 161\ m^3/\text{company per year}$$

Average sludge production per company for companies with neutralization, settling and sludge dewatering =

$$0.05\ V = 8.05\ m^3/\text{company per year}$$

4. No. of companies to install treatment:

No. of companies without treatment that were covered by the 1983/84 survey = 296 - 160 = 136 companies.

Percent without treatment = 136/296 = 46%

Therefore,

Total no. of companies to install treatment systems
= 0.46 x 673
= 309 companies

5. Volume of incremental sludge produced:

Assume all companies install sludge dewatering, the total incremental volume of waste produced would be 8.05 m^3/year/company x 309.

= 2490 m^3/yr

6. Mass of incremental sludge produced:

M = Volume of sludge x density of water x sp. grav. of sludge (assume 1.1)

M = 2490 x 1.0 x 1.1
= 2740 tonnes/yr (wet basis)

B.4 METHOD B2--INCLUDING ADJUSTMENT FOR TREATMENT SYSTEMS INSTALLED PRIOR TO MISA IMPLEMENTATION

B.4.1 TREATMENT SYSTEMS INSTALLED SINCE 1983

In Method B1, it is assumed that no additional treatment systems were installed since 1983.

However, it is reported that stricter surveillance of metal finishers by sewage treatment plants and stricter by-laws have forced a number of companies to install conventional treatment systems since 1983.

Therefore, to give a more realistic estimate of incremental sludge production, it is assumed that 70 percent of metal finishers will have conventional treatment systems with dewatering prior to MISA implementation (Edwards, 1988; Forrestal, 1988; Portugais, 1988).

This assumption impacts on the number of new treatment systems required as a result of MISA.

1. Number of companies to install treatment:

Assume percent without treatment = 30%

Therefore,

Total no. of companies to install treatment systems
= 0.30 x 673
= 202 companies

2. Volume of incremental sludge produced:

Incremental volume = 202 x 8.05
= 1626 m^3/yr

3. Mass of incremental sludge produced:

Mass = 1626 x 1.0 x 1.1
= 1790 tonnes/yr (wet basis)

APPENDIX C

LIST OF CONTACTS

Appendix C
LIST OF CONTACTS

Name	Affiliation	Phone Number
Frank Altmayer	Chicago Metal Finishers Association	312/254-2406
John Archer	MOE Municipal Group	416/323-4978
Tom Baumgarten	MOE Hamilton	416/521-7707
Chang Bek	Michigan Department of Natural Resources	517/373-1220
Mary Belefski	U.S. Environmental Protection Agency (Met Fin)	202/382-7153
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